

DIPLOMA IN RENEWABLE ENERGY

Syllabus

Program Code: 25DRE01



2025 – 2026 Onwards

CENTRE FOR DISTANCE AND ONLINE EDUCATION - CDOE

BHARATHIAR UNIVERSITY

(A State University, Accredited with “A++” Grade by NAAC,

Ranked 46th among Indian Universities by MoE-NIRF,

Coimbatore - 641 046, Tamil Nadu, India.

BHARATHIAR UNIVERSITY :: COIMBATORE 641046
CENTRE FOR DISTANCE AND ONLINE EDUCATION (CDOE)

VISION

To become a centre of excellence in renewable energy education and training that empowers learners to lead the transition toward a sustainable, low-carbon future through innovation, technology, and community engagement.

MISSION

- **To impart** foundational and applied knowledge in renewable energy systems, technologies, and sustainable practices.
- **To develop** skilled technicians and professionals capable of designing, installing, operating, and maintaining renewable energy systems effectively.
- **To promote** innovation, entrepreneurship, and research in renewable and sustainable energy solutions addressing local, national, and global challenges.
- **To collaborate** with industries, research organizations, and government agencies for experiential learning and technology transfer.
- **To instil** ethical, environmental, and social responsibility among learners for sustainable development and green growth.

TITLE OF THE PROGRAM

DIPLOMA IN RENEWABLE ENERGY

DURATION

- **Minimum Duration:** One year
- **Maximum Duration:** Two years (with provision for Re-registration if required)

CREDIT DISTRIBUTION

- **Total Credits:** 40 credits (as per UGC credit framework)

ELIGIBILITY

- Candidates must have completed Higher Secondary (10+2) or equivalent examination.

MEDIUM OF INSTRUCTION

- Medium of Instruction is English. However, the learners are permitted to write the Continuous Internal Assessment and End Semester Examination in English.

MODE OF LEARNING

- Open and Distance Learning (ODL)
- The programme shall be conducted through remote learning using a blend of print and digital learning materials, supplemented by occasional Personal Contact Program (PCP) sessions to facilitate learner interaction and academic support

FEES STRUCTURE

- Fee structure as approved by the Centre for Distance and Online Education, Bharathiar University, Coimbatore.

ATTENDANCE

Particulars	Requirement for Diploma Programme
Number of Personal Contact Programs (PCPs)	20 PCPs
Duration of Each PCP	6 hours per PCP
Total Contact Hours	12 hours per course (120 hours)
Total Study Hours of Learners	1200 hours
Mandatory Participation	75% in each course

REQUIREMENT TO APPEAR FOR THE EXAMINATIONS

A candidate enrolled in the programme shall be required to maintain the minimum prescribed attendance in both theory and practical classes, pay the prescribed examination fees, and satisfy all other conditions as stipulated by the University from time to time in order to be eligible to appear for the examinations.

CONDITIONS TO APPEAR FOR THE EXAMINATIONS

- **First Appearance:** Learners appearing for the examination for the first time shall register for all the prescribed courses of that semester by remitting the requisite examination fee.
- **Examination Centre:** Learners must specify their preferred examination centre in the examination application form. Once selected, the examination centre cannot be changed under any circumstances.
- **E-Hall Ticket:** Learners shall download their E-Hall Tickets from the University website and obtain the signature of the Chief Superintendent of the opted examination centre upon submission of their valid identity card. This process must be completed during the three working days preceding the commencement of the examinations.

EVALUATION PATTERN

A. Distribution of Marks in Continuous Internal Assessments (CIA): 25% weightage

The following procedure shall be followed for awarding internal marks for theory courses.

- Continuous Internal Assessment (CIA) Test - 10 marks
- Assignment - 5 marks
- Seminar - 5 marks
- Participation - 5 marks
- Total - 25 marks**

1. CIA Test and question pattern:

Two Continuous Internal Assessments (CIA-I & CIA II) must be conducted. Better of the TWO (the best and favorable one) will be counted for Test Marks (10 Marks)

- Section A – Objective Question $5*1 = 5$ marks
- Section B – Short Essay (2 out of 3) $2*5 = 10$ marks
- Section C – Essay Type (Either or type) $1*10 = 10$ marks

2. **Assignments – I and II.** Better of the TWO (the best one) will be counted for Assignment Marks (5 Marks)

3. **Seminar** will be conducted for 5 Marks.

4. **Participation** (which includes attendance) – 5 Marks

B. Project/Dissertation/Internship (4 Credits) – At the end of Second Semester

- Major project / Internship (100 marks)
Internal – 50 Marks & External – 50 Marks

C. End-Semester Examination (ESE): 75% weightage

Mode and Duration of Examinations

1. Mode of Examination: All examinations shall be conducted offline at designated physical locations such as the University campus or approved Learner Support Centres (LSCs), under the supervision of duly appointed invigilators and as per the fixed examination schedule notified by the University.
2. Duration: Each examination shall be of three (3) hours' duration, covering both theoretical concepts and their practical applications.

Distribution of Marks in the End-Semester Examination - Question Paper Pattern:

Section	Type of question	No. of questions	Marks	Total
A	Objective Questions	10 (Compulsory)	1	10
B	Short Essay (300 words each)	3 out of 5	5	15
C	Essay Type (1000 words each)	5 Questions (Either or Type)	10	50
Total				75

D. Passing Criteria:

- A minimum of 40% aggregate marks, combining internal and external assessments, shall be required to pass each course.
- Minimum 40% passing marks in practical / project component
- Aggregate of 40% marks required for successful completion of the diploma programme.

E. Grading System: (As per 10-point UGC Credit Framework)

- The following table gives the marks, grade points, letter, grades and classification to Indicate the performance of the candidate.

For the entire programme:

- $CGPA = \text{Sum of the multiplication of grade points by the credits of the entire programme} / \text{Sum of the credits of the courses for the entire programme.}$

$$\text{Cumulative Grade Point Average (CGPA)} = \frac{\sum n \sum i C_{ni} G_{ni}}{\sum n \sum i C_{ni}}$$

RANGE	CGPA	GRADE	CLASSIFICATION OF RESULT
95-100	9.5-10.0	O+	First Class- Exemplary*
90-94	9.0 and above but below 9.5	O	
85-89	8.5 and above but below 9.0	D++	First Class with Distinction*
80-84	8.0 and above but below 8.5	D+	
75-79	7.5 and above but below 8.0	D	
70-74	7.0 and above but below 7.5	A++	First Class
65-69	6.5 and above but below 7.0	A+	
60-64	6.0 and above but below 6.5	A	
55-59	5.5 and above but below 6.0	B+	Second Class
50-54	5.0 and above but below 5.5	B	
45-49	4.5 and above but below 5.0	C+	Third Class
40-44	4.0 and above but below 4.5	C	
0-39	0.0 and above but below 4.0	U	Re-appear

- a. A candidate who has passed all the courses in the first appearance within the prescribed duration of the diploma programmes and secured a CGPA of 9 to 10 and equivalent grades “O” or “O+” in Core and Practical/Project courses shall be placed in the category of “**First Class – Exemplary**”.
- b. A candidate who has passed all the courses in the first appearance within the prescribed duration of the Diploma programmes and secured a CGPA of 7.5 to 9 and equivalent grades “D” or “D+” or “D++” in Core and Practical/Project courses shall be placed in the category of “**First Class with Distinction**”.
- c. A candidate who has passed all the courses of the Diploma programmes and secured a CGPA of 6 to 7.4 and equivalent grades “A” or “A+” or “A++” in Core and Practical/Project courses shall be declared to have passed in “**First Class**”.
- d. A candidate who has passed all the courses examination of the Diploma programmes and secured a CGPA of 5.0 to 5.9 and equivalent grades “B” or “B+” in Core and Practical/Project courses shall be declared to have passed in “**Second Class**”.
- e. A candidate who has passed all the courses examination of the Diploma programmes and secured a CGPA of 4.0 to 4.9 and equivalent grades “C” or “C+” in Core and Practical/Project courses shall be declared to have passed in “**Third Class**”.

Program Educational Objectives (PEOs)	
<i>Diploma in Renewable Energy</i> are designed to prepare graduates for professional success and societal contribution in the growing renewable energy sector. Within a few years of completing the program, graduates will be able to:	
PEO 1	Professional Expertise: Apply fundamental scientific and engineering principles to analyze, design, and operate renewable energy systems including solar, wind, biomass, hydro, and hybrid technologies.
PEO 2	Technological Competence & Innovation: Demonstrate technical competence, creativity, and adaptability in applying emerging technologies, tools, and simulation software in renewable energy system development.
PEO 3	Employability & Lifelong Learning: Pursue successful careers in industry, government, or entrepreneurial ventures, and engage in continuous professional development and lifelong learning in sustainable energy domains.
PEO 4	Ethical, Environmental & Social Responsibility: Exhibit professional ethics, environmental awareness, and social responsibility in addressing global and local energy challenges toward sustainable development.
PEO 5	Communication & Leadership: Demonstrate effective communication, teamwork, project management, and leadership skills in multidisciplinary environments and community-based energy initiatives.

Program Specific Outcomes (PSOs)	
After successful completion of the Diploma in Renewable Energy, the learners will be able to:	
PSO 1	Application of Renewable Energy Principles: Apply scientific and engineering fundamentals to design, analyze, and implement renewable energy systems such as solar, wind, biomass, hydro, and hybrid technologies for sustainable energy generation.
PSO 2	Technical Proficiency and System Integration: Use modern tools, simulation software, and experimental techniques to evaluate performance, optimize efficiency, and integrate renewable energy systems with smart grids and energy storage technologies.
PSO 3	Project Management and Professional Competence: Demonstrate technical competence, teamwork, communication, and leadership in executing renewable energy projects, industrial training, and community-based initiatives with ethical and environmental responsibility.
PSO 4	Innovation, Entrepreneurship, and Lifelong Learning: Engage in continuous learning, research, and innovation to develop sustainable business models, contribute to policy development, and promote entrepreneurship in the renewable energy sector.

Program Outcomes (POs)	
Upon successful completion of the Diploma in Renewable Energy, learners will be able to:	
PO1	Knowledge Application: Apply the principles of science and engineering to understand, analyze, and operate renewable energy systems such as solar, wind, biomass, and hydro technologies.
PO2	Problem Analysis: Identify, formulate, and analyse problems related to energy generation, conversion, and utilization, leading to sustainable and efficient solutions.
PO3	Design and Development: Design and develop renewable energy components, systems, or processes that meet environmental, economic, and societal needs.
PO4	Conduct Investigations: Use experimental methods, simulations, and data analysis to evaluate performance and improve renewable energy systems.
PO5	Modern Tool Usage: Apply modern tools, software, and technologies (such as PVsyst, HOMER, MATLAB) for modelling, design, and performance assessment of renewable energy projects.
PO6	The Engineer and Society: Demonstrate awareness of professional, ethical, and social responsibilities in implementing renewable energy solutions for community and industrial needs.
PO7	Environment and Sustainability: Understand the environmental impact of energy systems and promote sustainability through renewable energy adoption and conservation measures.
PO8	Ethics: Adopt ethical practices and uphold professional integrity in energy-related decisions, operations, and project management.

PO9	<p>Individual and Team Work:</p> <p>Function effectively as an individual and as a member or leader in multidisciplinary teams during projects, laboratory work, and field training.</p>
PO10	<p>Communication Skills:</p> <p>Communicate effectively through technical reports, presentations, and discussions with industry professionals, stakeholders, and the community.</p>
PO11	<p>Project Management and Finance:</p> <p>Apply management principles and economic analysis for planning, executing, and evaluating renewable energy projects.</p>
PO12	<p>Lifelong Learning:</p> <p>Recognize the need for and engage in lifelong learning to keep pace with emerging renewable technologies and policies.</p>

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CENTRE FOR DISTANCE AND ONLINE EDUCATION (CDOE)

DIPLOMA IN RENEWABLE ENERGY

(For the students admitted during the academic year 2025 – 26 onwards)

Course Code	Title of the Course	Credits	Hours		Maximum Marks		
			Theory	Practical	CIA	ESE	Total
FIRST SEMESTER							
25DRE101	Fundamentals of Renewable Energy	4	12	--	25	75	100
25DRE102	Solar Energy Technologies	4	12	--	25	75	100
25DRE103	Wind Energy Systems	4	12	--	25	75	100
25DRE104	Biomass & Bioenergy	4	12	--	25	75	100
25DRE105	Renewable Energy Laboratory – I	4	--	24	25	75	100
Total		20	48	24	125	375	500
SECOND SEMESTER							
25DRE201	Energy Storage & Smart Grid	4	12	--	25	75	100
25DRE202	Hydro & Emerging Renewable Technologies	4	12	--	25	75	100
25DRE203	Energy Economics, Policy & Management	4	12	--	25	75	100
25DRE204	Renewable Energy Laboratory – II	4	--	24	25	75	100
25DRE205	Major Project & Viva	4	--	--	50	50	100
		20	48	24	150	350	500
Grand Total		40	96	48	275	725	1000

Course Code	25DRE101	TITLE OF THE COURSE	Credits	PCP Hours	Study hours of Learners
Core paper		FUNDAMENTALS OF RENEWABLE ENERGY	4	12	120
Pre-requisite		Basic knowledge of physics and mathematics at the undergraduate level, including concepts of mechanics, thermodynamics, and basic electrical science.		Syllabus Version	1

Course Objectives

The main objectives of this course are to:

1. Provide students with a fundamental understanding of various forms of energy, their transformation, and the concept of sustainability.
2. Familiarize students with the global and Indian energy scenarios, emphasizing the transition from conventional to renewable energy systems.
3. Introduce the basic principles of thermodynamics and energy conversion relevant to renewable energy technologies.
4. Develop awareness of national and international energy policies, institutional frameworks, and regulatory mechanisms.
5. Equip students with the skills to perform basic energy audits, assess energy efficiency, and identify conservation opportunities.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

CO1:	Explain the fundamental concepts of energy, power, and sustainability, and describe the global and Indian energy scenarios.	K1, K2
CO2:	Differentiate between conventional and renewable energy systems and evaluate their environmental and economic impacts.	K2, K5
CO3:	Interpret and analyze national and international energy policies, missions, and institutional frameworks related to renewable energy.	K3, K4
CO4:	Apply the basic laws of thermodynamics and heat transfer principles to energy conversion systems.	K3
CO5:	Perform preliminary energy audits, calculate efficiency metrics, and recommend suitable energy conservation measures.	K4, K5, K6

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

BLOCK 1	ENERGY BASICS AND SUSTAINABILITY
	<ul style="list-style-type: none"> <input type="checkbox"/> Meaning of energy and its common forms (mechanical, electrical, thermal, chemical) <input type="checkbox"/> Basic idea of work, power and energy with simple units <input type="checkbox"/> Renewable and non-renewable energy sources <input type="checkbox"/> Limited and unlimited energy resources <input type="checkbox"/> Energy use in India (overview) <input type="checkbox"/> Relationship between energy use and environment <input type="checkbox"/> Environmental effects of fossil fuels <input type="checkbox"/> Need for energy conservation and sustainable development
BLOCK 2	SOLAR ENERGY SYSTEMS
	<ul style="list-style-type: none"> <input type="checkbox"/> Sun as a source of energy and basic idea of solar radiation <input type="checkbox"/> Simple methods of measuring sunlight (pyranometer, sunshine recorder – introduction only) <input type="checkbox"/> Solar energy potential in India (overview) <input type="checkbox"/> Principle of solar heating and cooling <input type="checkbox"/> Solar thermal devices: solar cooker, solar water heater, solar dryer <input type="checkbox"/> Introduction to solar thermal power plants <input type="checkbox"/> Working principle of solar cells (photovoltaic effect) <input type="checkbox"/> Types of solar panels <input type="checkbox"/> Applications of solar energy: lighting, water pumping, rooftop and grid-connected systems
BLOCK 3	WIND AND SMALL HYDRO POWER SYSTEMS
	<ul style="list-style-type: none"> <input type="checkbox"/> Formation of wind and basic working principle of wind energy <input type="checkbox"/> Factors affecting wind power (wind speed, location, height) – concept only <input type="checkbox"/> Wind energy potential in India (overview) <input type="checkbox"/> Types of wind turbines and their main parts <input type="checkbox"/> Small-scale wind power applications <input type="checkbox"/> Basic idea of hydropower generation <input type="checkbox"/> Types of hydro power plants (large, small, micro) <input type="checkbox"/> Main components of a hydro power plant (turbine, generator, penstock) <input type="checkbox"/> Basic site and environmental considerations
BLOCK 4	BIOMASS & EMERGING RENEWABLE ENERGY SOURCES
	<ul style="list-style-type: none"> <input type="checkbox"/> Meaning and types of biomass energy <input type="checkbox"/> Common biomass resources and their uses <input type="checkbox"/> Biogas plant – construction, working, and applications <input type="checkbox"/> Biomass-based power generation (basic idea) <input type="checkbox"/> Introduction to geothermal energy <input type="checkbox"/> Tidal, wave, and ocean thermal energy (OTEC) – basic concepts <input type="checkbox"/> Hydrogen as a clean energy source <input type="checkbox"/> Basic idea of hydrogen production and storage <input type="checkbox"/> Introduction to fuel cells and their applications

BLOCK 5	ENERGY MANAGEMENT, POLICIES & FUTURE TRENDS
<ul style="list-style-type: none"> <input type="checkbox"/> Importance of energy saving and conservation <input type="checkbox"/> Basic idea of energy audit and energy management <input type="checkbox"/> Energy-efficient devices and appliances <input type="checkbox"/> Government support for renewable energy in India <input type="checkbox"/> Role of MNRE and other renewable energy agencies <input type="checkbox"/> National solar and wind programmes (overview) <input type="checkbox"/> Incentives and subsidies for renewable energy (basic idea) <input type="checkbox"/> Introduction to new renewable energy technologies <input type="checkbox"/> Energy storage and hybrid energy systems <input type="checkbox"/> Examples of successful renewable energy projects in India 	
Text Book(s)	
<ol style="list-style-type: none"> 1. G.D. Rai, <i>Non-Conventional Energy Sources</i>, Khanna Publishers. 2. S.P. Sukhatme and J.K. Nayak, <i>Solar Energy: Principles of Thermal Collection and Storage</i>. 3. B.H. Khan, <i>Non-Conventional Energy Resources</i>. 4. Twidell and Weir, <i>Renewable Energy Resources</i>, Taylor & Francis. 	
Reference Books	
<ol style="list-style-type: none"> 1. S. Rao and B.B. Parulekar (2017), <i>Energy Technology: Non-Conventional, Renewable and Conventional</i> (4th Edition), Khanna Publishers, New Delhi. 2. R.K. Rajput (2019), <i>Non-Conventional Energy Sources and Utilisation</i>, S. Chand & Company Ltd., New Delhi. 3. D.P. Kothari, K.C. Singal, and Rakesh Ranjan (2019), <i>Renewable Energy Sources and Emerging Technologies</i> (3rd Edition), PHI Learning Pvt. Ltd., New Delhi. 4. A.E. Keir and D. Weatherall (2016), <i>Energy Efficiency: Principles and Practices</i> Routledge, London. 	
Course Designed By: Dr.P.Dhanasekaran, Assistant Professor of Physics, Centre for Distance and Online Education (CDOE), Bharathiar University, Coimbatore - 46.	
Web link: NPTEL: Fundamentals of Renewable Energy (IIT Bombay, IIT Madras) SWAYAM: Renewable Energy Engineering MNRE India: https://mnre.gov.in IREDA: https://ireda.in	

CO / PO MAPPING FOR FUNDAMENTALS OF RENEWABLE ENERGY

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	M	L	L	L	M	S	L	L	M	L	M
CO2	M	S	M	L	L	M	S	M	L	M	L	M
CO3	M	M	M	L	L	S	S	M	L	S	M	S
CO4	S	S	S	M	M	L	M	L	L	L	L	M
CO5	M	S	M	S	S	M	S	M	M	M	S	S

S-Strong, M-Moderate, L-Low

Course Code	25DRE102	TITLE OF THE COURSE	Credits	PCP Hours	Study hours of Learners
Core paper	SOLAR ENERGY TECHNOLOGIES		4	12	120
Pre-requisite	Basic understanding of Physics — concepts of energy, heat transfer, radiation, and electricity.			Syllabus Version	1
Course Objectives					
<ol style="list-style-type: none"> 1. To provide fundamental knowledge on solar energy principles, solar radiation, and the role of solar power in sustainable energy systems. 2. To understand the design and working principles of various solar thermal and solar photovoltaic (PV) systems for energy conversion. 3. To develop technical skills in selecting, sizing, installing, and maintaining solar energy systems for diverse applications. 4. To familiarize students with the balance of system components, performance evaluation, and operational aspects of solar installations. 5. To expose learners to emerging solar technologies, energy storage systems, and national policies promoting solar energy adoption. 6. To enable students to perform basic techno-economic analysis of solar energy projects and assess their environmental and social benefits. 					
Expected Course Outcomes:					
On the successful completion of the course, student will be able to:					
CO1	Explain the fundamental principles of solar radiation, solar geometry, and energy conversion processes.			K1, K2	
CO2	Distinguish between different types of solar collectors and photovoltaic devices and describe their operating principles.			K2, K3	
CO3	Design and analyze small-scale solar PV and thermal systems for specific applications such as lighting, water heating, and pumping.			K3, K4	
CO4	Evaluate the performance, efficiency, and maintenance requirements of solar energy systems.			K4, K5	
CO5	Assess the techno-economic feasibility of solar energy projects and interpret national policies and programs related to solar power.			K5	
CO6	Propose innovative solutions or hybrid systems integrating solar energy with other renewable sources for sustainable energy management.			K6	
K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 – Create					

BLOCK 1	SOLAR ENERGY BASICS & ENVIRONMENTAL BENEFITS
<ul style="list-style-type: none"> <input type="checkbox"/> Sun as the main source of energy <input type="checkbox"/> Basic idea of solar radiation <input type="checkbox"/> Simple understanding of sunlight reaching the earth <input type="checkbox"/> Basic instruments used to measure sunlight (introduction only) <input type="checkbox"/> Types of solar radiation: direct and indirect (concept only) <input type="checkbox"/> Solar energy availability in India (overview) <input type="checkbox"/> Importance of solar energy for sustainable development <input type="checkbox"/> Advantages of solar energy over fossil fuels <input type="checkbox"/> Environmental and social benefits of using solar energy 	
BLOCK 2	SOLAR THERMAL ENERGY SYSTEMS
<ul style="list-style-type: none"> <input type="checkbox"/> Basic idea of converting sunlight into heat <input type="checkbox"/> Simple working principle of solar thermal systems <input type="checkbox"/> Main parts of a solar thermal system (absorber, glass cover, insulation) <input type="checkbox"/> Flat plate solar collectors – construction and working <input type="checkbox"/> Introduction to concentrating solar collectors (overview only) <input type="checkbox"/> Common applications of solar thermal energy: <ul style="list-style-type: none"> • Solar water heater • Solar cooker • Solar dryer <input type="checkbox"/> Other uses: solar desalination and industrial heating (introductory) 	
BLOCK 3	SOLAR PHOTOVOLTAIC (PV) SYSTEMS
<ul style="list-style-type: none"> <input type="checkbox"/> Basic idea of converting sunlight into electricity <input type="checkbox"/> Simple working principle of a solar cell <input type="checkbox"/> Common types of solar panels (overview) <input type="checkbox"/> Construction and ratings of a solar PV module <input type="checkbox"/> Series and parallel connection of solar panels (concept only) <input type="checkbox"/> Main factors affecting PV performance (sunlight, temperature, shading) <input type="checkbox"/> Basic idea of Maximum Power Point Tracking (MPPT) <input type="checkbox"/> Balance of system components: inverter, charge controller, battery <input type="checkbox"/> Introduction to solar PV system layout and applications 	
BLOCK 4	SOLAR PV SYSTEMS – INSTALLATION & APPLICATIONS
<ul style="list-style-type: none"> <input type="checkbox"/> Basic idea of stand-alone and grid-connected solar PV systems <input type="checkbox"/> Simple load calculation for small solar systems (concept only) <input type="checkbox"/> Main components of a solar PV system: panel, battery, inverter <input type="checkbox"/> Common applications: solar street lights, water pumps, home lighting <input type="checkbox"/> Introduction to rooftop and grid-connected solar systems <input type="checkbox"/> Basic idea of net metering and grid safety <input type="checkbox"/> Site selection and layout for solar PV installation <input type="checkbox"/> Basic wiring, protection and earthing practices 	

- Operation, routine checking and simple maintenance of PV systems

BLOCK 5**ADVANCED SOLAR TECHNOLOGIES, STORAGE & POLICIES**

- Introduction to new solar technologies (overview)
- Solar concentrator systems for power generation (basic idea)
- Hybrid solar systems (solar PV with other energy sources)
- Floating solar power plants and agrivoltaics systems (concept only)
- Need for energy storage in solar systems
- Types of solar energy storage: batteries and thermal storage (introductory)
- Basic idea of battery storage and its use with solar PV systems
- Government support for solar energy in India
- Role of MNRE and national solar programmes
- Examples of solar power projects in India

Text Book(s)

1. Chetan Singh Solanki, *Solar Photovoltaics: Fundamentals, Technologies and Applications*, PHI Learning.
2. Sukhatme S.P. & Nayak J.K., *Solar Energy: Principles of Thermal Collection and Storage*, TMH.
3. G.D. Rai, *Non-Conventional Energy Sources*, Khanna Publishers.

Reference Books

1. D.Y. Goswami, F. Kreith, and J.F. Kreider, *Principles of Solar Engineering*, 3rd Edition, Taylor & Francis, 2015.
2. Tiwari, G.N. and Ghosal, M.K., *Renewable Energy Resources: Basic Principles and Applications*, Narosa Publishing House, New Delhi, 2016.
3. Kothari, D.P., Singal, K.C., and Rakesh Ranjan, *Renewable Energy Sources and Emerging Technologies*, PHI Learning Pvt. Ltd., 2020.

Course Designed By:

Dr.P.Dhanasekaran, Assistant Professor of Physics, Centre for Distance and Online Education (CDOE), Bharathiar University, Coimbatore - 46.

Web link:

<https://www.phindia.com/Books/BookDetail/9788120351110/solar-photovoltaics--fundamentals-technologies-and-applications?srsltid=AfmBOoobWsTsXb9UJ6xNyLL5jfv0tvJQFa8T8G8YZI1SY0PC1>
https://books.google.com/books/about/Solar_Energy.html?id=1-XHcwZo9XwX

CO /PO MAPPING FOR SOLAR ENERGY TECHNOLOGIES

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	M	L	L	L	L	M	L	L	L	L	M
CO2	S	S	M	L	M	L	M	L	L	L	L	M
CO3	M	S	S	M	S	L	M	L	M	M	M	M
CO4	M	S	M	S	S	L	S	L	M	M	M	M
CO5	L	M	S	M	M	S	S	M	M	S	S	M
CO6	M	M	S	M	S	S	S	M	S	S	S	S

S-Strong, M-Moderate, L-Low

Course Code	25DRE103	TITLE OF THE COURSE	Credits	PCP Hours	Study hours of Learners
Core paper		WIND ENERGY SYSTEMS	4	12	120
Pre-requisite	Basic knowledge of Physics, Energy Conversion Systems, Understanding of mechanical principles.			Syllabus Version	1

Course Objectives

1. To introduce the fundamental principles of wind energy conversion and the characteristics of wind resources.
2. To familiarize students with the design, components, and operation of various types of wind turbines and their control systems.
3. To develop understanding of the electrical aspects of wind energy systems, including generators, power electronics, and grid integration.
4. To train students in site assessment, planning, installation, and maintenance of wind farms.
5. To analyse the economic, environmental, and policy aspects influencing the deployment of wind energy systems in India and globally.

Expected Course Outcomes:

On the successful completion of the course, student will be able to:

CO1	Explain the basic principles, origin, and characteristics of wind energy resources.	K1
CO2	Interpret wind measurement data and assess the potential of wind energy sites.	K2
CO3	Describe the working principles, design, and components of various wind turbine systems.	K2
CO4	Apply knowledge of electrical and mechanical systems to analyse power generation and control in wind energy systems.	K3
CO5	Evaluate the performance, operation, and maintenance aspects of wind farms.	K5
CO6	Examine the economic, environmental, and policy factors affecting wind energy deployment.	K4
CO7	Design small-scale wind energy systems for specific applications considering technical and economic feasibility.	K6

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

BLOCK 1	WIND ENERGY BASICS & RESOURCE ASSESSMENT
<ul style="list-style-type: none"> <input type="checkbox"/> Basic idea of how wind is formed <input type="checkbox"/> Wind as a source of renewable energy <input type="checkbox"/> Advantages and limitations of wind energy <input type="checkbox"/> Wind energy scenario in India (overview) <input type="checkbox"/> Important wind characteristics: speed and direction (concept only) <input type="checkbox"/> Basic instruments used to measure wind (anemometer, wind vane) <input type="checkbox"/> Simple idea of wind site selection <input type="checkbox"/> Introduction to wind resource assessment <input type="checkbox"/> Basic understanding of wind energy potential 	
BLOCK 2	WIND TURBINES – WORKING & COMPONENTS
<ul style="list-style-type: none"> <input type="checkbox"/> Basic working principle of wind turbines <input type="checkbox"/> Simple idea of lift and drag in wind turbine blades <input type="checkbox"/> Types of wind turbines: horizontal axis and vertical axis <input type="checkbox"/> Main parts of a wind turbine: blades, hub, gearbox, generator, nacelle, tower <input type="checkbox"/> Basic control systems: yaw, pitch and braking (concept only) <input type="checkbox"/> Onshore and offshore wind turbines (overview) <input type="checkbox"/> Introduction to modern wind turbine designs 	
BLOCK 3	ELECTRICAL SYSTEMS & GRID CONNECTION OF WIND TURBINES
<ul style="list-style-type: none"> <input type="checkbox"/> Basic role of electrical generators in wind turbines <input type="checkbox"/> Common types of generators used in wind turbines (overview only) <input type="checkbox"/> Simple idea of fixed speed and variable speed wind turbines <input type="checkbox"/> Need for power electronics in wind energy systems <input type="checkbox"/> Basic function of converters and inverters <input type="checkbox"/> Simple concept of maximum power extraction from wind (MPPT – idea only) <input type="checkbox"/> Introduction to connecting wind turbines to the electrical grid <input type="checkbox"/> Basic power quality issues (voltage and power factor – concept only) <input type="checkbox"/> Importance of safety and protection during grid connection 	
BLOCK 4	WIND POWER PROJECTS – SITE SELECTION, INSTALLATION & MAINTENANCE
<ul style="list-style-type: none"> <input type="checkbox"/> Basic idea of selecting a suitable site for wind turbines <input type="checkbox"/> Important factors for site selection: wind availability, land, and access <input type="checkbox"/> Environmental considerations for wind power projects (overview) <input type="checkbox"/> Introduction to wind turbine installation process <input type="checkbox"/> Basic steps in erection, cabling, and commissioning <input type="checkbox"/> Simple performance checking after installation <input type="checkbox"/> Importance of safety during installation and operation <input type="checkbox"/> Routine operation and basic maintenance of wind turbines <input type="checkbox"/> Introduction to fault identification and remote monitoring 	

BLOCK 5	WIND ENERGY ECONOMICS, POLICIES & FUTURE TRENDS
<ul style="list-style-type: none"> <input type="checkbox"/> Basic idea of costs involved in wind energy projects <input type="checkbox"/> Simple understanding of operation and maintenance cost <input type="checkbox"/> Government support for wind energy in India <input type="checkbox"/> Role of MNRE, IREDA and state renewable energy agencies <input type="checkbox"/> Introduction to wind energy policies and incentives <input type="checkbox"/> Overview of future wind energy technologies <input type="checkbox"/> Offshore wind power (basic idea) <input type="checkbox"/> Hybrid wind–solar power systems <input type="checkbox"/> Role of energy storage and smart grids in wind power 	
Text Book(s)	
<ol style="list-style-type: none"> 1. S. N. Bhadra, D. Kastha, & S. Banerjee – <i>Wind Electrical Systems</i>, Oxford University Press. 2. E. Hau – <i>Wind Turbines: Fundamentals, Technologies, Application, Economics</i>, Springer. 3. Manwell, McGowan & Rogers – <i>Wind Energy Explained</i>, Wiley. 	
Reference Books	
<ol style="list-style-type: none"> 1. <i>Wind Energy Explained: Theory, Design and Application</i> — J. F. Manwell, J. G. McGowan, A. L. Rogers. 2. <i>Wind Turbines: Fundamentals, Technologies, Application, Economics</i> — E. Hau. 	
<p>Course Designed By:</p> <p>Dr.P.Dhanasekaran, Assistant Professor of Physics, Centre for Distance and Online Education (CDOE), Bharathiar University, Coimbatore - 46.</p>	
<p>Web link:</p> <p>https://www.iu.edu.jo/media/k2/attachments/Wind_energy_systems_IU.pdf?utm_source=chatgpt.com</p> <p>https://www.pvpsiddhartha.ac.in/autonomous19/41/eee/WIND%20AND%20SOLAR%20ENERGY%20SYSTEMS.pdf?utm_source=chatgpt.com</p>	

CO /PO MAPPING FOR WIND ENERGY SYSTEMS

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	M	L	L	L	L	S	L	L	M	L	M
CO2	M	S	M	S	M	L	S	L	L	M	L	M
CO3	S	M	S	M	M	L	M	L	L	L	L	L
CO4	S	S	S	S	S	L	M	L	L	L	M	M
CO5	M	S	M	S	S	L	S	L	M	L	M	M
CO6	L	M	M	L	L	S	S	M	L	M	S	S
CO7	S	S	S	M	S	M	M	L	M	M	S	M

S-Strong, M-Moderate, L-Low

Course Code	25DRE104	TITLE OF THE COURSE	Credits	PCP Hours	Study hours of Learners
Core paper		BIOMASS & BIOENERGY	4	12	120
Pre-requisite	Basic knowledge of physics, chemistry, and renewable energy fundamentals.			Syllabus Version	1
Course Objectives					
<ol style="list-style-type: none"> 1. To understand the fundamentals of biomass resources and their energy potential. 2. To study various biomass conversion technologies. 3. To explore biochemical and thermochemical processes for bioenergy production. 4. To learn about biogas, biofuels, and waste-to-energy systems. 5. To analyze the sustainability and environmental impacts of bioenergy systems. 					
Expected Course Outcomes:					
On the successful completion of the course, student will be able to:					
CO1	Identify and classify biomass resources and their properties.			K1, K2	
CO2	Explain biochemical and thermochemical biomass conversion technologies.			K2, K3	
CO3	Design small-scale bioenergy systems for rural applications.			K3, K4	
CO4	Evaluate the efficiency and environmental impact of bioenergy systems.			K4, K5	
CO5	Apply knowledge for sustainable biomass utilization in energy generation.			K3, K5	
K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 – Create					
BLOCK 1	BIOMASS ENERGY – BASICS & RESOURCES				
<ul style="list-style-type: none"> <input type="checkbox"/> Meaning and importance of biomass energy <input type="checkbox"/> Common types of biomass resources <input type="checkbox"/> Examples of biomass sources in India <input type="checkbox"/> Availability of biomass and its energy potential (overview) <input type="checkbox"/> Basic characteristics of biomass as a fuel <input type="checkbox"/> Factors affecting energy production from biomass (concept only) <input type="checkbox"/> Uses of agricultural waste, forest waste, and industrial organic waste <input type="checkbox"/> Role of biomass energy in rural and sustainable development 					
BLOCK 2	BIOMASS ENERGY CONVERSION METHODS				
<ul style="list-style-type: none"> <input type="checkbox"/> Basic idea of converting biomass into useful energy <input type="checkbox"/> Main methods of biomass conversion (thermochemical and biological – overview) <input type="checkbox"/> Simple understanding of biomass burning (combustion) for heat and power 					

- Basic stages of biomass combustion
- Introduction to biomass gasification (conversion of biomass into gas fuel)
- Uses of producer gas (heating, electricity generation – overview)
- Basic idea of biomass pyrolysis and its products
- Applications of biomass conversion technologies

BLOCK 3

BIOGAS & BIOFUELS FROM BIOMASS

- Basic idea of producing energy from organic waste
- Simple working principle of a biogas plant
- Types of biogas plants (household and community level – overview)
- Raw materials used for biogas production (animal waste, food waste, crop waste)
- Uses of biogas for cooking, lighting, and electricity generation
- Introduction to biofuels such as bioethanol
- Common raw materials used for ethanol production
- Basic idea of ethanol blending with petrol
- Applications of biofuels in vehicles and power generation

BLOCK 4

BIODIESEL, WASTE-TO-ENERGY & INTEGRATED BIOMASS SYSTEMS

- Basic idea of biodiesel as an alternative fuel
- Common sources of biodiesel (vegetable oils and waste oils)
- Simple understanding of biodiesel production process (overview only)
- Uses of biodiesel in engines and generators
- Introduction to solid waste and municipal waste
- Concept of converting waste into useful energy
- Basic idea of waste-to-energy methods (RDF, incineration, landfill gas)
- Introduction to integrated biomass energy systems
- Biomass energy use in rural and decentralized applications
- Examples of biomass power and waste-to-energy projects in India

BLOCK 5

ENVIRONMENTAL IMPACT, POLICIES & FUTURE TRENDS OF BIOMASS ENERGY

- Environmental benefits of biomass energy
- Reduction of pollution and greenhouse gas emissions
- Basic idea of carbon-neutral energy
- Simple understanding of costs involved in biomass energy projects
- Government support for biomass energy in India
- Role of MNRE and national biomass programmes
- Overview of international trends in biomass energy
- Introduction to advanced biofuels and new technologies
- Algae-based bioenergy (basic idea)
- Future scope and job opportunities in biomass energy

Text Book(s)

1. S. C. Bhattacharya, *Biomass Energy in Asia: Conversion Technologies and Policy*, Oxford University Press.
2. Demirbas, A., *Bioenergy: Global Prospects and Perspectives*, Springer.
3. C.Y. Wereko-Brobby and E.B. Hagan, *Biomass Conversion and Technology*, Wiley.

Reference Books

1. K. M. Mital, *Biogas Systems: Principles and Applications*, New Age International.
2. MNRE (Govt. of India) – Reports and guidelines on biomass and bioenergy.

Course Designed By:

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Web link:

- 🌐 <https://nptel.ac.in/courses/103107125> — NPTEL Course on Biomass & Bioenergy
- 🌐 <https://mnre.gov.in> — Ministry of New and Renewable Energy, Govt. of India
- 🌐 <https://swayam.gov.in> — Online courses on Renewable Energy Systems

CO / PO MAPPING FOR BIOMASS & BIOENERGY

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	M	L	L	L	M	S	L	L	L	L	M
CO2	S	S	M	M	M	L	S	L	L	L	L	M
CO3	S	S	S	M	S	M	M	L	M	M	S	M
CO4	M	S	M	S	M	M	S	L	L	M	M	S
CO5	S	M	M	M	M	S	S	M	L	L	M	S

S-Strong, M-Moderate, L-Low

Course Code	25DRE105	TITLE OF THE COURSE	Credits	PCP Hours	Study hours of Learners
Core Practical 1		RENEWABLE ENERGY LABORATORY – I	4	24	120
Pre-requisite		Basic knowledge of physics, chemistry, and renewable energy fundamentals.		Syllabus Version	1
Course Objectives					
<ol style="list-style-type: none"> 1. To provide hands-on experience in measuring and evaluating solar, wind, and biomass energy systems. 2. To develop skills in operating instruments and equipment used in renewable energy experiments. 3. To enable students to analyze the performance and efficiency of solar PV, thermal, and hybrid systems. 4. To familiarize students with energy conversion, storage, and power conditioning components. 5. To cultivate the ability to interpret experimental data for assessing the feasibility of renewable energy technologies. 					
Expected Course Outcomes:					
On the successful completion of the course, student will be able to:					
CO1	Measure and analyze solar radiation using appropriate instruments to assess solar energy potential.			K3	
CO2	Evaluate the I–V characteristics and efficiency of solar cells and PV modules under various conditions.			K4	
CO3	Conduct performance tests on solar thermal systems such as flat plate collectors and solar water heaters to determine thermal efficiency.			K4	
CO4	Examine the power output characteristics of small wind turbine models and interpret wind speed–power relationships.			K4	
CO5	Test and evaluate power conditioning and storage components such as charge controllers, batteries, and inverters used in renewable systems.			K3	
CO6	Estimate biogas yield and solar distillation output, and analyze the efficiency and quality of renewable energy-based systems.			K5	
K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 – Create					

List of Experiments

1. **Study of solar panel, inverter and battery** – identification of components and ratings
2. **Measurement of solar panel voltage and current** under sunlight and shade
3. **Determination of power output of a solar panel** at different time intervals
4. **Solar lighting system demonstration** (panel–battery–lamp connection)
5. **Study of a solar street light system** – components and working
6. **Wind turbine model study** – parts, working principle and applications
7. **Observation of wind speed vs turbine output** using a small wind model (demonstration)
8. **Biogas plant model study** – construction, working and uses
9. **Simple solar cooker experiment** – heating and cooking performance
10. **Energy audit of a classroom / home** – identification of energy saving opportunities

Text Book(s)

1. Laboratory Manual for Renewable Energy Technology: Especially useful for the lab component — experiment procedures, instrumentation etc.

Reference Books

1. Renewable Energy: A First Course: A good introductory textbook for students, covering basics of solar, wind and biomass.
2. Fundamentals Of Renewable Energy: Focuses on the fundamental principles of renewable energy systems — helpful for lab understanding.
3. A Text Book of Renewable Energy Resources: More focused on the resources side (availability, characteristics) which aligns with measurement labs.

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Web link:

https://eternaluniversity.edu.in/docs/RenewableEnergyandGreenTechnology.pdf?utm_source=chatgpt.com

https://benthambooks.com/book/9781681087191/?utm_source=chatgpt.com

https://link.springer.com/content/pdf/10.1007/978-981-99-9710-7.pdf?utm_source=chatgpt.com

https://dde.pondiuni.edu.in/files/StudyMaterials/MBA/MBA4SemesterElective/MBEP4004-RenewableEnergy_WM.pdf?utm_source=chatgpt.com

CO /PO MAPPING FOR RENEWABLE ENERGY LABORATORY – I

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	M	-	S	-	-	M	-	-	-	-	-
CO2	S	S	M	S	M	-	M	-	-	-	-	-
CO3	S	M	S	S	-	-	S	-	-	-	-	-
CO4	S	S	M	S	M	-	S	-	-	-	-	-
CO5	M	S	M	S	S	-	-	-	-	-	M	-
CO6	M	M	S	S	-	-	S	-	-	-	-	M

S-Strong, M-Moderate, L-Low

Course Code	25DRE201	TITLE OF THE COURSE	Credits	PCP Hours	Study hours of Learners
Core paper	ENERGY STORAGE & SMART GRID		4	12	120
Pre-requisite	Basic knowledge of electrical systems, power generation, and renewable energy technologies.			Syllabus Version	1
Course Objectives					
<ol style="list-style-type: none"> 1. To understand the need and principles of energy storage in modern power systems. 2. To explore various energy storage technologies and their characteristics. 3. To study smart grid concepts, architecture, and enabling technologies. 4. To integrate renewable energy sources with storage and smart grid systems. 5. To analyse energy management, communication, and control in smart grids. 					
Expected Course Outcomes:					
On the successful completion of the course, student will be able to:					
CO1	Explain the need and classification of energy storage systems.			K1, K2	
CO2	Describe working principles and characteristics of electrochemical and mechanical storage systems.			K2, K3	
CO3	Analyse smart grid components, communication systems, and automation technologies.			K3, K4	
CO4	Integrate renewable energy with grid and storage systems.			K4, K5	
CO5	Evaluate the performance, control, and challenges of smart grids.			K4, K5	
K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 – Create					
BLOCK 1	ENERGY STORAGE – BASICS & APPLICATIONS				
<ul style="list-style-type: none"> <input type="checkbox"/> Meaning and importance of energy storage <input type="checkbox"/> Why energy storage is needed in power systems <input type="checkbox"/> Common types of energy storage (battery, thermal, mechanical – overview) <input type="checkbox"/> Role of energy storage in solar and wind energy systems <input type="checkbox"/> Problems of renewable energy variation and power supply balance <input type="checkbox"/> Use of energy storage for backup power and peak load support <input type="checkbox"/> Basic applications of energy storage in homes, industries, and power grids <input type="checkbox"/> Examples of energy storage use in solar and wind power systems 					
BLOCK 2	MECHANICAL & THERMAL ENERGY STORAGE SYSTEMS				
<ul style="list-style-type: none"> <input type="checkbox"/> Basic idea of storing energy in mechanical form <input type="checkbox"/> Introduction to flywheel energy storage (simple working idea) <input type="checkbox"/> Concept of compressed air energy storage (CAES) <input type="checkbox"/> Basic working principle of pumped hydro storage <input type="checkbox"/> Meaning of thermal energy storage 					

- Sensible and latent heat storage (concept only)
- Use of thermal storage in solar heating systems
- Introduction to new mechanical energy storage methods
- Environmental benefits of mechanical and thermal energy storage

BLOCK 3	BATTERY, HYDROGEN & ELECTRICAL ENERGY STORAGE SYSTEMS
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- Basic idea of storing energy using batteries
- Common types of batteries used in energy systems (lead-acid, lithium-ion – overview)
- Simple uses of batteries in solar, wind, and backup power systems
- Introduction to fuel cells as an energy conversion device
- Hydrogen as an energy storage medium (basic idea)
- Use of hydrogen and fuel cells with renewable energy sources
- Basic idea of electrical energy storage systems
- Introduction to supercapacitors and magnetic energy storage (overview)
- Hybrid energy storage systems and their applications

BLOCK 4	SMART GRID – BASICS & APPLICATIONS
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- Meaning of a smart grid
- Need for smart grids in modern power systems
- Difference between conventional grid and smart grid (basic idea)
- Main parts of a smart grid: generation, transmission, distribution, and consumers
- Introduction to smart meters and their uses
- Role of sensors and control systems in smart grids (overview)
- Basic idea of communication in smart grids
- Automation and remote monitoring of power systems
- Benefits of smart grids for renewable energy integration and consumers

BLOCK 5	SMART GRID APPLICATIONS, ENERGY MANAGEMENT & FUTURE TRENDS
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- Integration of renewable energy sources like solar and wind with the power grid
- Role of energy storage in improving grid reliability and power supply
- Basic idea of hybrid systems and microgrids
- Importance of energy management in modern power systems
- Use of smart meters for monitoring and controlling energy use
- Simple concept of load management and demand response
- Introduction to electric vehicles (EVs) and smart charging
- Vehicle-to-grid (V2G) concept (basic idea)
- Benefits of smart grids for consumers and utilities
- Examples of smart grid and renewable energy projects

Text Book(s)

1. Ali Keyhani, *Design of Smart Power Grid Renewable Energy Systems*, Wiley-IEEE Press.
2. James Larminie & Andrew Dicks, *Fuel Cell Systems Explained*, Wiley.
3. A. G. Ter-Gazarian, *Energy Storage for Power Systems*, IET.

Reference Books

1. R. Ramakumar, *Energy Storage Systems*, Springer.
2. Jean-Michel Gauthier, *Smart Grids: Fundamentals and Technologies in Electricity Networks*, Wiley.

Course Designed By:

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Web link:

- 🌐 <https://nptel.ac.in/courses/108107127> — NPTEL: Smart Grid Technology
- 🌐 <https://mnre.gov.in> — Ministry of New and Renewable Energy
- 🌐 <https://ieee.org/smartgrid> — IEEE Smart Grid Resource Centre
- 🌐 <https://swayam.gov.in> — SWAYAM Courses on Renewable Energy and Grid Systems

CO / PO MAPPING FOR ENERGY STORAGE & SMART GRID

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	M	L	L	L	M	S	L	L	L	L	M
CO2	S	S	M	M	M	L	M	L	L	L	L	M
CO3	M	S	S	S	S	M	M	L	M	M	M	S
CO4	S	S	S	M	S	M	S	L	M	M	S	S
CO5	M	S	M	S	S	M	S	L	M	M	M	S

S-Strong, M-Moderate, L-Low

Course Code	25DRE202	TITLE OF THE COURSE	Credits	PCP Hours	Study hours of Learners
Core paper		HYDRO & EMERGING RENEWABLE TECHNOLOGIES	4	12	120
Pre-requisite	Fundamental knowledge of energy systems, basic fluid mechanics, and renewable energy concepts.			Syllabus Version	1
Course Objectives					
<ol style="list-style-type: none"> 1. To introduce the fundamentals and components of hydro power systems. 2. To study small, mini, and micro hydro power technologies. 3. To understand design and operation principles of hydroelectric plants. 4. To explore emerging renewable technologies such as tidal, wave, OTEC, and geothermal energy. 5. To analyse the integration, environmental, and economic aspects of emerging technologies. 					
Expected Course Outcomes:					
On the successful completion of the course, student will be able to:					
CO1	Explain the principles and types of hydroelectric power systems.			K1, K2	
CO2	Describe the design, working, and operation of hydraulic turbines and components.			K2, K3	
CO3	Apply concepts of small and micro-hydro power system development.			K3, K4	
CO4	Illustrate the principles of tidal, wave, geothermal, and OTEC systems.			K2, K3	
CO5	Evaluate the feasibility and sustainability of emerging renewable energy technologies.			K4, K5	
K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 – Create					
BLOCK 1	HYDROPOWER – BASICS & POWER PLANT COMPONENTS				
<ul style="list-style-type: none"> <input type="checkbox"/> Meaning and importance of hydropower <input type="checkbox"/> Types of hydropower plants: large, small, mini, and micro (overview) <input type="checkbox"/> Hydropower potential in India (general idea) <input type="checkbox"/> Simple understanding of water flow and height in hydropower generation <input type="checkbox"/> Basic idea of selecting a suitable site for a hydropower plant <input type="checkbox"/> Main parts of a hydropower plant: dam, reservoir, penstock, turbine, generator <input type="checkbox"/> Basic layout and working of a hydropower plant <input type="checkbox"/> Simple operation and control of hydropower systems 					
BLOCK 2	HYDRAULIC TURBINES & SYSTEMS IN HYDRO POWER PLANTS				

- Basic working principle of hydraulic turbines
- Types of turbines: impulse and reaction (simple idea)
- Introduction to Pelton, Francis, and Kaplan turbines
- Selection of turbines based on water flow and height (concept only)
- Main parts of a turbine and their functions
- Basic idea of speed control and governing systems
- Introduction to electrical systems used in hydro plants
- Safety systems and basic operation of hydro power plants
- Routine maintenance and common problems in turbines

BLOCK 3

SMALL HYDRO POWER (SHP) SYSTEMS

- Meaning and importance of small hydro power
- Types of SHP systems: mini, micro, and pico hydro (overview)
- Basic idea of selecting a site for a small hydro plant
- Main parts of a small hydro system: intake, penstock, turbine, powerhouse
- Simple working of a small hydro power plant
- Introduction to low-cost and small turbines used in SHP
- Basic installation practices for small hydro systems
- Operation and routine maintenance of SHP plants
- Environmental and social benefits of small hydro projects
- Examples of small hydro power projects in India

BLOCK 4

OCEAN & GEOTHERMAL ENERGY SYSTEMS

- Basic idea of energy from oceans and the earth
- Simple working principle of tidal energy
- Types of tidal power plants (overview)
- Basic components used in tidal power systems
- Introduction to wave energy and its applications
- Basic idea of ocean thermal energy conversion (OTEC)
- Different OTEC systems (introductory only)
- Basic concept of geothermal energy
- Types of geothermal power plants (overview)
- Potential and scope of ocean and geothermal energy in India

BLOCK 5

HYBRID RENEWABLE SYSTEMS, IMPACTS & FUTURE TRENDS

- Meaning and need for hybrid renewable energy systems
- Advantages of combining different renewable sources
- Examples of hybrid systems: hydro–solar and hydro–wind
- Basic idea of hybrid microgrids for rural and remote areas
- Role of energy storage in hybrid renewable systems
- Environmental benefits of hybrid renewable energy
- Simple understanding of environmental protection measures
- Basic idea of cost and feasibility of hybrid systems
- Introduction to floating solar–hydro systems

- Overview of future renewable energy technologies and innovations

Text Book(s)

1. S. K. Garg, *Hydrology and Water Resources Engineering*, Khanna Publishers.
2. Bansal, N.K. et al., *Renewable Energy Sources and Conversion Technology*, Tata McGraw-Hill.
3. A. M. D. Rao, *Small Hydro Power Systems*, BSP Books Pvt. Ltd.

Reference Books

1. Godfrey Boyle (Ed.), *Renewable Energy: Power for a Sustainable Future*, Oxford University Press.
2. K. K. Tiwari & M. K. Ghosh, *Renewable Energy Resources – Conversion Technology*, Narosa Publishing.

Course Designed By:

Dr.P.Dhanasekaran, Assistant Professor of Physics, Centre for Distance and Online Education (CDOE), Bharathiar University, Coimbatore - 46.

Web link:

- 🌐 <https://nptel.ac.in/courses/108105058> — NPTEL Course on Hydropower Engineering
- 🌐 <https://mnre.gov.in> — Ministry of New and Renewable Energy, Govt. of India
- 🌐 <https://swayam.gov.in> — MOOC courses on Emerging Energy Systems
- 🌐 <https://irade.org> — Research on emerging renewable energy technologies

CO / PO MAPPING FOR HYDRO & EMERGING RENEWABLE TECHNOLOGIES

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	M	L	L	L	M	S	L	L	L	L	M
CO2	S	S	M	S	M	L	M	L	L	L	L	M
CO3	S	S	S	M	S	M	M	L	M	M	S	M
CO4	M	M	M	L	L	S	S	M	L	L	M	S

S-Strong, M-Moderate, L-Low

Course Code	25DRE203	TITLE OF THE COURSE	Credits	PCP Hours	Study hours of Learners
Core paper		ENERGY ECONOMICS, POLICY & MANAGEMENT	4	12	120
Pre-requisite	Basic understanding of energy systems, renewable energy technologies, and general economics.			Syllabus Version	1
Course Objectives					
<ol style="list-style-type: none"> 1. To introduce the fundamentals of energy economics and the concept of energy demand and supply. 2. To study methods for economic analysis and evaluation of energy projects. 3. To understand national and international energy policies and regulatory frameworks. 4. To explore the principles of energy management and audit. 5. To analyse policy instruments, market mechanisms, and sustainable energy strategies. 					
Expected Course Outcomes:					
On the successful completion of the course, student will be able to:					
CO1	Understand basic concepts of energy economics, pricing, and demand-supply mechanisms.			K1, K2	
CO2	Apply economic analysis and costing principles to energy projects.			K2, K3	
CO3	Explain national and international energy policies and their impacts.			K2, K3	
CO4	Demonstrate the principles and practices of energy management and audit.			K3, K4	
CO5	Evaluate the role of policy, markets, and sustainability in energy systems.			K4, K5	
K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 – Create					
BLOCK 1	ENERGY ECONOMICS – BASICS & DEMAND				
<ul style="list-style-type: none"> <input type="checkbox"/> Meaning and importance of energy economics <input type="checkbox"/> Relationship between energy use and economic development <input type="checkbox"/> Overview of energy demand and supply in India and the world <input type="checkbox"/> Basic idea of pricing of energy resources (coal, oil, gas, electricity) <input type="checkbox"/> Factors affecting energy prices (availability, demand, government policies) <input type="checkbox"/> Simple understanding of energy tariffs and subsidies <input type="checkbox"/> Meaning of energy demand and factors influencing energy use <input type="checkbox"/> Importance of energy conservation and demand management <input type="checkbox"/> Role of efficient energy use in reducing energy costs 					
BLOCK 2	ENERGY PROJECT ECONOMICS & COMPARISON				

- Basic idea of evaluating energy projects
- Simple understanding of project cost and benefits
- Meaning of investment, operating cost, and maintenance cost
- Concept of project payback period (idea only)
- Importance of reducing risk in energy projects
- Comparison of conventional and renewable energy projects (general idea)
- Factors affecting the cost of solar, wind, and biomass projects
- Simple examples of renewable energy projects in India
- Importance of renewable energy for long-term cost savings

BLOCK 3

ENERGY POLICIES & GOVERNMENT SUPPORT

- Meaning and importance of energy policies
- Role of government in energy planning and development
- Overview of energy and renewable energy policies in India
- Role of MNRE and other energy-related institutions
- Importance of energy conservation and efficiency laws (basic idea)
- Introduction to global energy organizations
- International efforts for clean energy and climate protection
- Basic idea of government incentives for renewable energy
- Importance of policies in promoting clean and sustainable energy

BLOCK 4

ENERGY MANAGEMENT, AUDIT & CONSERVATION

- Meaning and objectives of energy management
- Importance of managing energy in institutions and industries
- Role and responsibilities of an energy manager (basic idea)
- Simple understanding of energy audit and its purpose
- Types of energy audit (preliminary and detailed – overview)
- Basic methods of identifying energy wastage
- Introduction to common energy audit tools (concept only)
- Energy conservation techniques in electrical systems (lighting, motors, appliances)
- Energy conservation techniques in thermal systems (heating and cooling)
- Importance of energy-efficient appliances and star labeling

BLOCK 5

SUSTAINABLE ENERGY STRATEGIES & FUTURE OUTLOOK

- Meaning and importance of sustainable energy
- Role of clean and green energy in development
- Basic idea of planning energy use for long-term sustainability
- Transition from fossil fuels to renewable energy sources
- Importance of affordable and reliable energy for all
- Simple understanding of energy markets and power supply systems
- Role of government and private sector in energy development
- Introduction to smart energy systems and digital energy management
- Challenges in achieving sustainable energy goals
- Future scope and career opportunities in sustainable energy sector

Text Book(s)

1. A. V. Desai (Ed.), *Non-Conventional Energy*, Wiley Eastern.
2. Y. P. Abbi & Shashank Jain, *Handbook on Energy Audit and Environment Management*, TERI Press.
3. P. Meier, *Energy Economics: Theory and Applications*, Springer.

Reference Books

1. Subhes C. Bhattacharyya, *Energy Economics: Concepts, Issues, Markets and Governance*, Springer.
2. MNRE & BEE, *Energy Conservation Act and Policy Documents*, Government of India publications.

Course Designed By:

Dr.P.Dhanasekaran, Assistant Professor of Physics, Centre for Distance and Online Education (CDOE), Bharathiar University, Coimbatore - 46.

Web link:

- 🌐 <https://beeindia.gov.in> — Bureau of Energy Efficiency
- 🌐 <https://mnre.gov.in> — Ministry of New and Renewable Energy, Govt. of India
- 🌐 <https://nptel.ac.in/courses/110107123> — NPTEL Course on Energy Economics and Policy
- 🌐 <https://iea.org> — International Energy Agency
- 🌐 <https://swayam.gov.in> — MOOC Courses on Energy Policy and Management

CO / PO MAPPING FOR ENERGY ECONOMICS, POLICY & MANAGEMENT

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	M	L	L	L	S	S	M	L	L	S	M
CO2	S	S	S	M	M	M	M	L	M	M	S	S
CO3	M	M	M	L	L	S	S	S	L	M	M	S
CO4	S	S	S	S	S	M	S	M	M	M	S	S
CO5	M	M	M	M	M	S	S	S	M	M	S	S

S-Strong, M-Moderate, L-Low

Course Code	25DRE204	TITLE OF THE COURSE	Credits	PCP Hours	Study hours of Learners
Core Practical 2		RENEWABLE ENERGY LABORATORY – II	4	12	120
Pre-requisite		Fundamentals of Renewable Energy Systems, Electrical circuits and measurements, Energy conversion principles and basic thermodynamics.		Syllabus Version	1
Course Objectives					
<ol style="list-style-type: none"> 1. To provide practical exposure to advanced and hybrid renewable energy systems including solar, wind, hydro, and fuel cells. 2. To develop skills in designing, testing, and integrating various renewable energy components and subsystems. 3. To enable students to use modern instruments and control systems for performance monitoring and data acquisition. 4. To enhance understanding of energy auditing, efficiency analysis, and power quality assessment in renewable systems. 5. To promote innovative thinking toward emerging renewable technologies and their real-world applications. 					
Expected Course Outcomes:					
On the successful completion of the course, student will be able to:					
C01	Analyze and interpret the I–V characteristics and performance of PV systems, including shading and MPPT operation.			K4	
C02	Design and test hybrid renewable systems integrating PV, wind, and battery components for optimal load sharing.			K4	
C03	Conduct an energy audit of small facilities and prepare a report with efficiency improvement suggestions.			K3	
C04	Perform testing and performance evaluation of small hydropower turbine models to understand energy conversion principles.			K4	
C05	Characterize energy storage and conversion devices such as batteries and fuel cells through experimental data analysis.			K3	
C06	Demonstrate the operation and monitoring of emerging renewable technologies (geothermal systems, grid-tie inverters, microcontroller-based monitoring) and assess power quality and system performance.			K5	
K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 – Create					

List of Experiments

1. **Solar panel installation demonstration** – mounting angle, direction and safety
2. **Wiring of a small solar PV system** (panel, charge controller, battery, load)
3. **Battery charging and discharging test** – voltage variation with time
4. **Testing of inverter (DC to AC)** – output voltage and load operation
5. **Installation and testing of a solar street light system**
6. **Load calculation for a small solar power system** (home / shop application)
7. **Design and testing of a hybrid solar-battery system** for lighting loads
8. **Maintenance practices for solar PV systems** – cleaning, wiring check, safety
9. **Demonstration of energy-efficient appliances** (LED, star-rated devices)
10. **Safety practices in renewable energy systems** – electrical, battery and rooftop safety

Text Book(s)

1. Chetan Singh Solanki, *Solar Photovoltaics: Fundamentals, Technologies and Applications*, PHI Learning Pvt. Ltd., 4th Edition, 2021.
2. Godfrey Boyle, *Renewable Energy: Power for a Sustainable Future*, Oxford University Press, 4th Edition, 2019.
3. B.H. Khan, *Non-Conventional Energy Resources*, McGraw Hill Education, 3rd Edition, 2017.
4. D.P. Kothari, K.C. Singal & Rakesh Ranjan, *Renewable Energy Sources and Emerging Technologies*, PHI Learning Pvt. Ltd., 3rd Edition, 2020.

Reference Books

1. John Twidell & Tony Weir, *Renewable Energy Resources*, Routledge, 4th Edition, 2021.
2. S.P. Sukhatme & J.K. Nayak, *Solar Energy: Principles of Thermal Collection and Storage*, Tata McGraw Hill, 4th Edition, 2020.
3. Ramesh, M.P. & Kumar, V., *Renewable Energy Systems: Design and Analysis*, Narosa Publishing, 2022.
4. Ewald F. Fuchs & Mohammad A.S. Masoum, *Power Conversion of Renewable Energy Systems*, Academic Press, 2018.

Course Designed By:

Dr.P.Dhanasekaran, Assistant Professor of Physics, Centre for Distance and Online Education (CDOE), Bharathiar University, Coimbatore - 46.

Web link:

<https://nptel.ac.in/courses/108105062>

<https://nptel.ac.in/courses/112105051>

<https://mnre.gov.in>

<https://nise.res.in>

CO / PO MAPPING FOR RENEWABLE ENERGY LABORATORY - II

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	S	M	S	M	-	M	-	-	-	-	-
CO2	S	S	S	S	S	-	S	-	M	-	M	-
CO3	M	S	S	M	M	S	S	-	M	S	S	-
CO4	S	M	S	S	M	-	S	-	-	-	-	-
CO5	S	S	M	S	S	-	M	-	-	-	-	M
CO6	S	M	S	S	S	-	S	-	M	-	M	S

S-Strong, M-Moderate, L-Low

Course Code	25DRE205	TITLE OF THE COURSE	Credits	PCP Hours	Study hours of Learners
Project / Viva		RENEWABLE ENERGY APPLICATIONS	4		
Pre-requisite		Fundamentals of Renewable Energy Systems.		Syllabus Version	1

Guidelines for Project Work and Viva-Voce

1. Purpose and Objectives

The Project Work and Viva-Voce are designed to:

1. Provide practical exposure to renewable energy technologies, design, analysis, and implementation.
2. Encourage students to apply theoretical knowledge to real-world renewable energy problems.
3. Develop research, analytical, and technical documentation skills.
4. Promote innovative and sustainable solutions aligned with national and global energy goals.
5. Enable evaluation of learner competencies in problem solving, communication, and professional ethics.

2. Nature of the Project

Projects must be application-oriented or analytical, preferably addressing one or more of the following renewable energy domains:

- Solar Energy Systems: PV, solar thermal, hybrid solar systems, solar water heating, energy storage, or smart control systems.
- Wind Energy: Wind resource assessment, turbine modeling, hybrid PV-wind integration, small wind system design.
- Biomass and Bioenergy: Biogas generation, biodiesel production, biomass combustion/gasification analysis.
- Hydro and Emerging Technologies: Small/micro-hydro systems, tidal, wave, geothermal, OTEC, or hybrid systems.
- Energy Management and Audit: Energy audit of small institutions, energy efficiency improvement, carbon footprint reduction.
- Smart Grids and Energy Storage: Battery/fuel cell modeling, grid integration, IoT-based energy monitoring.

Projects may be:

- Experimental (lab-based or field setup),
- Design / Simulation (software-based using PVsyst, RETScreen, HOMER, MATLAB, etc.),
- Analytical / Case Study, or
- Industrial / Institutional Study Project.

3. Project Duration and Credits

Component	Duration	Suggested Credits	Hours of Study / Workload
Project Work	8–10 weeks (minimum)	4 Credits	~120 hours
Viva-Voce	Conducted after submission	–	–

4. Project Proposal and Approval Process

1. Topic Identification:

Students shall select a project area relevant to the renewable energy course outcomes, in consultation with their guide/supervisor.

2. Proposal Submission:

Each student shall submit a Project Proposal (about 2–3 pages) containing:

- Title and objectives
- Background / literature review
- Methodology or experimental plan
- Expected outcomes
- Required materials / instruments / data sources

3. Approval:

The proposal shall be reviewed and approved by the Faculty Guide / Coordinator before the commencement of the project work.

4. Ethics Compliance:

Projects must follow academic integrity, safety regulations, and environmental ethics.

5. Project Execution and Supervision

- Each student shall work under the guidance of a faculty member from the Department of Physics / Renewable Energy or a recognized expert from industry/institution (with university approval).
- Periodic progress reports shall be maintained (minimum 3 progress entries).
- If the project involves fieldwork or industry data collection, prior permission and consent letters should be obtained.

6. Project Report Format

The final project report should be neatly typed and bound, following this structure:

1. Title Page – Including student details, course code, title, guide name, and institution.
2. Certificate – From the guide and institution (if applicable).
3. Acknowledgement
4. Abstract / Executive Summary (max. 250 words)
5. Table of Contents
6. List of Tables / Figures
7. Chapter 1: Introduction – Background, problem statement, objectives.
8. Chapter 2: Literature Review – Summary of related research/work.

9. Chapter 3: Methodology / System Design – Experimental setup, software design, flowcharts, instruments, and procedures.
10. Chapter 4: Results and Discussion – Data presentation, analysis, graphs, observations.
11. Chapter 5: Conclusion and Future Scope
12. References – IEEE / APA style.
13. Appendices – Data sheets, codes, additional figures.

Report should be 25–60 pages for Diploma level.

7. Evaluation Scheme

Component	Marks	Evaluation Criteria
Project Proposal & Review	10	Relevance, clarity, objectives
Project Execution / Work	30	Data collection, design, analysis, innovation
Report Quality	20	Technical content, format, documentation
Viva-Voce	40	Understanding, presentation, technical depth
Total Marks	100	–

Passing Minimum: 50% (aggregate of project and viva voce).

8. Viva-Voce Examination

- Conducted by Internal & External Examiners appointed by the Director, CDOE.
- Evaluation focuses on:
 - Understanding of theoretical background.
 - Experimental or analytical approach adopted.
 - Interpretation of results and problem-solving ability.
 - Communication clarity and presentation skill.
 - Relevance to renewable energy sustainability and innovation.

Students may be asked to demonstrate models, simulation results, or data visualizations during the viva.

9. Submission Deadlines

- Proposal submission: Within 4 weeks from project allotment.
- Final report submission: By the end of the semester / as notified by CDOE.
- Viva-voce: Conducted after approval of reports by the internal guide.

10. Certification and Archiving

Upon successful completion, the student shall submit:

1. One hard-bound copy of the project report.
2. One soft copy (PDF) to be archived in the CDOE digital repository.
3. A brief project summary (1 page) for documentation and display.