

DEPARTMENT OF PHYSICS

**Scheme and Syllabus for
BVoc (Honours) Programme in
Renewable Energy Management
Under Credit Semester System
(Outcome Based Education with Effect from 2025 Admissions)**



St Berchmans College

Founded 1992

AUTONOMOUS

College with Potential for Excellence

A+ in the Fifth Cycle of Reaccreditation by NAAC

Changanassery, Kerala, India 686101 | Affiliated to Mahatma Gandhi University, Kottayam

ACKNOWLEDGEMENT

The Board of Studies in Physics acknowledges the contributions from all the members in restructuring the Under Graduate syllabus for the four year BVoc (Renewable Energy Management) Hons Programme. The abundant support and recommendations from everyone have moulded this curriculum to its present form.

Thanking all for their cooperation to make this venture a success,

For the Board of Studies in Physics

Mr Ajai Jose (Chairman)



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Dr G Harikrishnan	Associate Professor & Head Department of Physics, Government College, Madappally.

EXPERT NOMINATED BY THE VICE-CHANCELLOR

Name	Official Address
Dr Biju P R	Professor, School of Pure and Applied Physics Mahatma Gandhi University, Kottayam.

ALUMNI REPRESENTATIVE

Name	Official Address
Dr Charles Jose	Assistant Professor, Department of Physics Cochin University of Science and Technology Kalamaserry, Kochi.

REPRESENTATIVE FROM MEDIA/INDUSTRY AND ALLIED AREAS

Name	Official Address
Dr Libin Scaria	Medical Physicist, St Mary's Medical centre Huntington, West Virginia, USA



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Dr Manuja M
Dr Subin P John (HoD) Renewable Energy Dept.
Prof Anoop A
Prof Aswani B
Prof Anju A
Dr Anjana S Nair
Prof Meenu Thomas



PROGRAMME OUTCOMES

- PO1:** Develop in-depth conceptual knowledge in the discipline for vertical growth and scholarly pursuits
- PO2:** Identify historical, theoretical, scientific, technological, economic philosophical, cultural, aesthetic and ethical bases of different disciplines and relate them effectively
- PO3:** Demonstrate problem solving skills, effective communication, interpersonal dynamics and resilience in global and local contexts
- PO4:** Transfer the knowledge of methods, skills, tools and systems of different disciplines for a sustainable and egalitarian world order
- PO5:** Generate need based innovative processes and products for personal and societal well-being

PROGRAM SPECIFIC OUTCOMES

- PSO1:** Understand the foundational theoretical and experimental principles of renewable energy systems, along with essential mathematical and communication skills, to support sustainable and energy-efficient practices.
- PSO2:** Understand the principles of energy infrastructure, rational energy use, energy policies, regulatory frameworks, and the energy–environment interface to support informed decision- making.
- PSO3:** Apply technical and analytical skills to solve real-world challenges related to the design, development, and implementation of renewable energy technologies in diverse professional settings.
- PSO4:** Analyse theoretical concepts and practical applications in renewable energy, energy conservation, and energy management to derive meaningful and data-informed conclusions.
- PSO5:** Apply innovative and practical solutions in the renewable energy sector through experiential learning approaches such as Hands-on Training (HOT), On-the-Job Training (OJT), and project-based activities



OUTLINE OF SKILL DEVELOPMENT COMPONENTS (SDC)

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
Semester I (Course Level: 100 - 199)					
SBU25RE1SDC100	SDC/Major	Mathematics for Renewable Energy	4	60	4
SBU25RE1SDC101	SDC/Major	Introduction to Renewable Energy	5	75	4
SBU25RE1SDC102	SDC/Major	Fundamentals of Solar Photovoltaics	5	75	4
SBU25RE1OJT01	SDC/Major	On the Job Training 1	5	75	2
Semester II (Course Level: 100 - 199)					
SBU25RE2SDC100	SDC/Major	Electrical fundamentals	4	60	4
SBU25RE2SDC101	SDC/Major	Solar Photovoltaic Installation	5	75	4
SBU25RE2SDC102	SDC/Major	Basic Electronics	5	75	4
SBU25RE2OJT01	SDC/Major	On the Job Training 2	5	75	2
Semester III (Course Level: 200 - 299)					
SBU25RE3SDC200	SDC/Major	Energy Conservation, Management and Auditing	4	60	4
SBU25RE3SDC201	SDC/Major	Material Science	5	75	4
SBU25RE3SDC202	SDC/Major	Wind power technology	5	75	4
SBU25RE3OJT01	SDC/Major	On the Job Training 3	5	75	2
Semester IV (Course Level: 200 - 299)					
SBU25RE4SDC200	SDC/Major	Project Management	4	60	4
SBU25RE4SDC201	SDC/Major	Hydro Power System and Ocean Energy	5	75	4
SBU25RE4SDC202	SDC/Major	Solar Photovoltaic Designing	5	75	4
SBU25RE2INT	SDC/Major	Internship (20 days on Sem Break)	-	2	
Semester V (Course Level: 300 – 399)					
SBU25RE5SDC300	SDC/Major	Fuel Cells and Hydrogen Energy	4	60	4
SBU25RE5SDC301	SDC/Major	Novel Energy Sources	5	75	4
SBU25RE5SDC302	SDC/Major	Geothermal Energy Systems	5	75	4
SBU25RE5SDC303	SDC/Major	Grid Integration and Smart Grid Technologies	5	75	4
Semester VI (Course Level: 400 - 499)					
SBU25RE6SDC300	SDC/Major	Solar Thermal Technology	5	75	4
SBU25RE6SDC301	SDC/Major	Advanced Solar Photovoltaics	5	75	4
SBU25RE6SDC302	SDC/Major	Electric Vehicles and Batteries	5	75	4
SBU25RE6PRJ	SDC/Major	Project	8	120	4

OUTLINE OF MULTIDISCIPLINARY COURSES (MDC)

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
Semester I (Course Level: 100 - 199)					
SBU25RE1MDC100	GEC/ Foundation	Renewable Energy in Daily Life	3	45	3
Semester II (Course Level: 100 - 199)					
SBU25RE2MDC100	GEC/ Foundation	Renewable Energy Sources	4	60	3



OUTLINE OF SKILL ENHANCEMENT COURSES (SEC)

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
Semester IV (Course Level: 200 - 299)					
SBU25RE4SEC200	GEC/ Foundation	Entrepreneurship Skills	3	45	3
Semester V (Course Level: 100 - 199)					
SBU25RE5SEC300	SDC/Major	Softwares for Renewable Energy System Design	4	60	3
Semester VI (Course Level: 300 - 399)					
SBU25RE6SEC300	SDC/Major	Energy storage systems	3	45	3

OUTLINE OF VALUE ADDITION COURSES (VAC)

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
Semester IV (Course Level: 200 - 299)					
SBU25RE4VAC200	GEC/ Foundation	Environmental studies and human rights	3	45	3
Semester V (Course Level: 100 - 199)					
SBU25RE5VAC300	GEC/ Foundation	Environment, Health and Safety in Industries	4	60	3
Semester VI (Course Level: 300 - 399)					
SBU25RE6VAC300	GEC/ Foundation	Carbon Audit and Management	3	45	3



SEMESTER I

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
Semester I (Course Level: 100 - 199)					
SBU25RE1SDC100	SDC/Major	Mathematics for Renewable Energy	4	60	4
SBU25RE1SDC101	SDC/Major	Introduction to Renewable Energy	5	75	4
SBU25RE1SDC102	SDC/Major	Fundamentals of Solar Photovoltaics	5	75	4
SBU25RE1OJT01	SDC/Major	On the Job Training 1	5	75	2
SBU25RE1MDC100	GEC/ Foundation	Renewable Energy in Daily Life	3	45	3



Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Differentiation				
Differentiation Rules-powers, multiples, sums and differences (proof not needed)	1.1	1,2	5	Lecture and problem solving
Differentiation-Products and Quotients, Negative integer power of x	1.2	1,2	4	Lecture and problem solving
Derivatives of trigonometric functions (proof not needed)	1.3	1,2	4	Lecture and problem solving
Differentiation-Chain Rule	1.4	1,2	3	Lecture and problem solving
Partial Derivatives-Functions of two variables (Definition only), Partial derivatives of a function of two variables	1.5	1,2	2	Lecture and problem solving
Partial Derivatives-Chain rule-functions of two variables	1.6	1,2	2	Lecture and problem solving
Module 2: Integration				
Indefinite integrals-definition	2.1	1,3	1	Lecture
Rules of algebra of antiderivatives	2.2	1,3	2	Lecture and problem solving
Trigonometric functions	2.3	1,3	4	Lecture and problem solving
The integrals of \sin^2x and \cos^2x	2.4	1,3	4	Lecture and problem solving
Definite integrals, evaluation of definite integrals	2.5	1,3	1	Lecture and problem solving
Properties of definite integrals	2.6	1,3	4	Lecture and problem solving
Integrals and total area	2.7	1,3	4	Lecture and problem solving
Module 3: Statistics				
Measures of Dispersion	3.1	1,4	1	Lecture
Range	3.2	1,4	1	Lecture
Mean, median, mode	3.3	1,4	2	Seminar/ Group discussion
Mean Deviation	3.4	1,4	2	Lecture and problem solving
Variance and standard Deviation	3.5	1,4	2	Lecture and problem solving
Analysis of frequency distributions	3.6	1,4	2	Lecture and problem solving
Module 4: Probability				
Introduction- Random Experiments- Outcome and sample space	4.1	1,5	2	Lecture
Event- Occurrence of an event, types of events	4.2	1,5	1	Assignment
Axiomatic Approach to Probability	4.3	1,5	1	Lecture and problem solving



Probability of an event	4.4	1,5	1	Lecture and problem solving
Probabilities of equally likely outcomes	4.5	1,5	2	Lecture and problem solving
Probability of the event 'A or B'	4.6	1,5	2	Lecture and problem solving
Probability of event 'not A'	4.7	1,5	1	Lecture and problem solving
Module 5: Teacher Specific Content <i>(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)</i> This content will be evaluated internally				

Reference

- 1) George B. Thomas Jr, *Thomas' Calculus*, 11th Edition, Pearson, 2008
- 2) Mathematics, Textbook for Class XI, NCERT

Course Designed by: Dr Subin P John



SBU25RE1SDC101:INTRODUCTION TORENEWABLE ENERGY

Type of Course	Major		
Course Level	100-199		
Credit	4		
Course Delivery Duration	Theory (Hrs)	Practical (Hrs)	Total (Hrs)
	45	30	75
Pre-requisite (if any)	None		

Course Outcomes

No.	Description	Cognitive Level
CO1	Learn and understand the necessity of units and dimensions.	U
CO2	Understand and identify different energy sources.	U
CO3	Identify the potential of solar energy and describe its applications	R
CO4	Understand the importance of few other renewable energy sources.	U
CO5	Demonstrate basic physics and renewable energy concepts through related experiments	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2					1			1	
CO2	1	1	1	2		2	2		1	
CO3	2	2	1	2		1	1			
CO4	2	2	1	2		1	2			
CO5	3	1	1	2	2	2		1	2	2

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Viva	Assignments	Seminar/ Group Discussion	Problem based assignments	Written test	
CO1	X				x	x
CO2	X	x			x	x
CO3	X		x		x	x
CO4	X			x	x	x
CO5						x

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Performance	Skill	Viva	Record	Model Exam	
CO1						
CO2						
CO3						
CO4						
CO5	x	x	x	x	x	x



Course Content and Transaction Mechanism Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1 Introduction to Measurement Fundamentals (15 Hrs)				
Introduction to physical quantities. Units – Fundamental and derived units.	1.1	1	2	Lecture
Basic Concepts in Measurement: Principal systems of units (CGS, MKS, SI).	1.2	1	2	Lecture
Energy Basics: Definition of energy, power, work (with units). SI Units in energy systems	1.3	1	2	Lecture and Problem Solving
Introduction to Energy Sources Energy sources and their availability.	1.4	2	2	Lecture
Classification of energy sources	1.5	2	2	Lecture and Problem Solving
Conventional and Renewable energy sources	1.6	2	2	Lecture
Need and importance of renewable energy in the modern world.	1.7	2	3	Lecture
Module 2: Solar Energy Technologies (15 Hrs)				
Solar water heating systems. Solar air heating and cooling systems	2.1	3	3	Lecture
Solar thermal electric conversion	2.2	3	3	Lecture and Problem Solving
Solar photovoltaic (PV) systems –Working principle, components	2.3	3	3	Lecture and Problem Solving
Other applications: Solar distillation	2.4	3	3	Lecture
Solar greenhouses, Furnaces, pumping	2.5	3	3	Lecture
Module 3: Other renewable energy sources (15 hours)				
Biomass and biogas plants	3.1	4	3	Lecture
Wind Energy	3.2	4	3	Lecture
Components of wind energy systems (blades, rotor, generator, tower)	3.3	4	3	Lecture
Ocean energy sources	3.4	4	3	Lecture
Geothermal energy-introduction	3.5	4	3	Lecture
Module 4: Teacher Specific Content (This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned) <p style="text-align: center;">This content will be evaluated internally</p>				

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 5: (30 Hrs)				
To demonstrate the conversion of solar energy into heat energy using a simple solar oven	5.1	5	5	Demonstration and peer learning
To study working of solar lights.	5.2	5	5	Demonstration and peer learning



To study solar radiation and its measurement	5.3	5	5	Demonstration and peer learning
To study the production process of biodiesel.	5.4	5	5	Activity
To study principle and working of solar cooker	5.5	5	5	Demonstration and peer learning
To study wind energy conversion system	5.6	5	5	Demonstration and peer learning

Textbooks

1. Chapter 1, Elements of Properties of matter: D. S. Mathur, 2000, 11th Edition, S. Chand and Co
2. Non-conventional energy sources; G. D. Rai; 2011; Fifth Edition, Khanna Publisher

Reference

1. Fundamentals of Physics; David Halliday & Robert Resnick; 2010; John Wiley & Sons
2. Non-conventional Energy Sources and Utilization (Energy Engineering); R. K. Rajput; 2012; 1st Edition.; S. Chand & Company Ltd

Course designed by Anju A



SBU25RE1SDC102: FUNDAMENTALS OF SOLAR PHOTOVOLTAICS

Type of Course	Major		
Course Level	100-199		
Credit	4		
Course Delivery Duration	Theory (Hrs)	Practical (Hrs)	Total (Hrs)
	45	30	75
Pre-requisite (if any)	None		

Course Outcomes

No.	Description	Cognitive Level
CO1	Explain the basic principles of solar radiation and its interaction with Earth's atmosphere and surfaces.	U
CO2	Understand the basics of the Solar energy and electrical energy	U
CO3	Differentiate between various types of solar PV technologies and SPV systems	U
CO4	Able to conduct site and load assessments	A
CO5	Install Civil and Mechanical Parts of Solar PV system.	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E – Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1					1				
CO2	2		1	1		1	1			
CO3	2		1			1		1		1
CO4	1	2	3	1	1	1		2		1
CO5	1		2		2	2		3	1	2

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Viva	Assignments	Seminar/ Group Discussion	Problem based assignments	Written test	
CO1	x				x	x
CO2	x	x			x	x
CO3	x		x		x	x
CO4	x			x	x	x
CO5	x				x	x

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Performance	Skill	Viva	Record	Model exam	
CO1				x	x	x
CO2	x		x	x	x	x
CO3				x	x	x
CO4		x		x	x	x
CO5				x	x	x



Course Content and Transaction Mechanism Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Introduction to Solar Energy and Electrical energy				
Introduction to Solar Energy	1.1	2	3	Lecture
Basics of Electrical Energy	1.2	2	3	Lecture
Ohm's Law: Electric Current, Voltage and Resistance	1.3	2	3	Lecture and problem solving
Connection in Series and Parallel	1.4	2	2	Lecture and problem solving
Earthing and Lightning Protection	1.5	2	2	Lecture
Measuring Instruments	1.6	2	2	Lecture
Module 2: Introduction to Solar Photovoltaics				
Terms and Definitions	2.1	1	3	Seminar/ Group discussion
Working Principle of a Solar Cell	2.2	3	3	Seminar/ Group discussion
Components of a Solar PV System	2.3	3	3	Seminar/ Group discussion
Types of Solar Photovoltaic Systems	2.4	3	3	Seminar/ Group discussion
Technical Parameters and Performance of a Solar PV Panel	2.5	3	3	Seminar/ Group discussion
Module 3: Solar PV designing and installation				
How to conduct a Site Assessment	3.1	4	3	Lecture and problem solving
How to conduct a Load Assessment	3.2	4	3	Lecture and problem solving
Identification and Uses of Tools and Equipment Used for Solar PV Installation	3.3	5	2	Lecture
Deriving a PV Solution from Customer Requirements	3.4	5	2	Lecture and problem solving
Procure Solar PV System Components	3.5	5	2	Lecture
Designing a Solar PV system	3.6	5	3	Lecture and problem solving
Module 4: Teacher Specific Content (This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned). This content will be evaluated internally				

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 5				
Ohm's Law	6.1	2	4	Practical



Familiarization with electrical measuring instruments	6.2	1	4	Practical/ Lab session
Multimeter - 1	6.3	2	4	Lab session
Multimeter – 2	6.4	2	4	Lab session
Introduction to Solar Photovoltaic technologies	6.5	4	4	Lab session
Introduction to Solar Thermal technologies	6.6	4	4	Lab session
I-V Curve plotting	6.7	4	6	Classroom Activity

References

1. Solar PV Installer (Suryamitra) Participant Handbook
2. Non-conventional Energy Sources and Utilization (Energy Engineering); R. K. Rajput; 2012; 1st Edition.; S. Chand & Company Ltd.

Course designed by Anoop A



SBU25RE1MDC100: RENEWABLE ENERGY IN DAILY LIFE

Type of Course	GEC/Foundation		
Course Level	100-199		
Credit	3		
Course Delivery Duration	Theory (Hrs)	Practical (Hrs)	Total (Hrs)
	45	0	45
Pre-requisite (if any)	None		

Course Outcomes

No.	Description	Cognitive Level
CO1	Understand the basics of renewable energy, energy types, and their role in sustainable living	U
CO2	Understand how individuals, communities, and policies support the renewable energy transition	U
CO3	Understand renewable energy concepts and technologies to real-life home and community settings	U
CO4	Understand practical solutions to local energy problems.	U
CO5	Understand the importance of energy conservation	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	3	2				2	1		1	
CO2	1	2				2	2	1		
CO3		1	2					2	1	
CO4		2		1			1		2	1
CO5		1		2		1			1	2

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Viva	Assignments	Seminar	Problem based assignments	Written test	
CO1	x				x	x
CO2	x	x			x	x
CO3	x	x		x	x	x
CO4	x		x	x	x	x
CO5	x		x		x	x

Course Content and Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Introduction to Renewable Energy and Its Role in Everyday Life (15 Hours)				
Basics of energy and renewable vs non- renewable energy	1.1	1	3	Lecture
Importance of renewable energy in sustainable living	1.2	1	2	Lecture
Energy consumption patterns in daily life, Carbon Footprint	1.3	1	2	Lecture
Role of individuals and communities in the energy transition	1.4	2	2	Lecture,
Government incentives and policies supporting household	1.5	2	3	Lecture



RE adoption				
Energy saving: Environmental and cost impacts of wasted energy	1.6	2	3	Lecture
Module 2: Renewable Energy Applications in Households (15 Hours)				
Solar PV systems for lighting, fan, phone charging, and backup	2.1	3	3	Lecture
Solar water heaters and solar cookers: technology and usage	2.2	3	2	Lecture
Biogas plants for cooking in rural/semi-urban areas	2.3	3	2	Lecture
Energy-efficient appliances and smart usage	2.4	3	2	Lecture
Waste water treatment	2.5	4	2	Lecture
Rainwater harvesting and solar-powered pumps	2.6	4	2	Lecture
Household case studies	2.7	4	2	Lecture
Module 3: Community and Lifestyle Applications of Renewable Energy (15 Hours)				
RE for rural development	3.1	4	1	Lecture
Rural vs urban energy access issues	3.2	4	3	Group Discussion
RE commercial purposes: Street lighting, microgrids, irrigation	3.3	5	3	Lecture
Green transport options: e-bikes, EVs, and solar charging stations	3.4	3,5	3	Group Discussion
RE in public buildings and institutions: schools, hospitals, offices	3.5	5	3	Group Discussion
Renewable energy and sustainable development goals	3.6	5	2	Activity
Module 4: Teacher Specific Content				
(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)				
This content will be evaluated internally				

Reference

1. Fundamentals of Renewable Energy by G.D. Rai, 2020, Khanna Publishers, New Delhi
2. Renewable Energy Sources and Emerging Technologies by D.P. Kothari, K.C. Singal, and Rakesh Ranjan, 2011, Prentice-Hall of India, New Delhi
3. Energy Conservation in the Chemical & Allied Industries by S.K. Awasthi, 1989, South Asian Publishers, New Delhi

Course designed by Anju A



SBU25RE1OJT01: ON THE JOB TRAINING 1

Type of Course	SDC/Major		
Course Level			
Credit	2		
Course Delivery Duration	Theory (Hrs)	Practical (Hrs)	Total (Hrs)
		75	75
Pre-requisite (if any)	OJT should be in done in a relevant field		

Course Outcomes

No.	Description	Cognitive Level
CO1	Demonstrate understanding of industry operations, standards, and professional expectations through direct exposure to workplace environments.	Understand
CO2	Apply job-specific skills effectively in real-world tasks and responsibilities within the assigned industry setting.	Apply
CO3	Integrate academic knowledge with practical applications to solve work-related challenges and contribute to organizational goals.	Analyse
CO4	Exhibit essential workplace competencies such as punctuality, accountability, communication, teamwork, and adaptability.	Apply
CO5	Identify and evaluate potential career opportunities by reflecting on their internship experiences and professional interactions.	Evaluate

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E – Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1		1		3	1	2	1	1	
CO2	2	1	2		3	3		2	1	1
CO3	1		1	1	3			3		
CO4			2		3	1	1	2	2	1
CO5	1		1		3	2		1	1	

Course designed by Anoop A



SEMESTER II

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
SBU25RE2SDC100	SDC/Major	Electrical fundamentals	4	60	4
SBU25RE2SDC101	SDC/Major	Solar Photovoltaic Installation	5	75	4
SBU25RE2SDC102	SDC/Major	Basic Electronics	5	75	4
SBU25RE2OJT01	SDC/Major	On the Job Training 2	5	75	2
SBU25RE2MDC100	GEC/ Foundation	Renewable Energy Sources	4	60	3



SBU25RE2SDC100: ELECTRICAL FUNDAMENTALS

Type of Course	SDC/Major		
Course Level	100-199		
Credit	4		
Course Delivery Duration	Theory (Hrs)	Practical (Hrs)	Total (Hrs)
	60	0	60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	To understand the basic concepts of electricity, circuits, and electrical machines.	U
CO2	Analyse and construct basic series and parallel circuits using standard electrical components.	U
CO3	Identify and explain the working principles of basic electrical machines and transformers used in energy systems.	R
CO4	Demonstrate awareness of electrical safety practices and correctly use measuring instruments and protective devices.	U
CO5	Relate basic electrical engineering principles to the functioning of renewable energy systems such as solar PV and wind turbines.	R

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E – Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	1	1	1		1	1		1	1
CO2	1			1		1		1	1	
CO3		1	1	1		1		1		1
CO4				1			1		1	
CO5	1	1	1			1		1	1	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Viva	Assignments	Seminar/ Group Discussion	Problem based assignments	Written test	
CO1	x	x	x		x	x
CO2	x	x		x	x	x
CO3	x		x		x	x
CO4	x	x	x	x	x	x
CO5	x	x		x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Basic Electrical Concepts and Laws				
Electric current, voltage, power, and energy. Basic circuit components: resistor, capacitor, inductor.	1.1	1	3	Lecture
Ohm's Law and its applications	1.2	1,2	3	Lecture & Problem



				solving
Types of circuits – series and parallel. Problem solving. Colour coding of resistors	1.3	2	3	Lecture & Problem solving
Introduction to AC and DC Electrical units and measuring instruments.	1.4	2	3	Lecture
Kirchhoff's Current and Voltage Laws (KCL & KVL) – Simple applications	1.5	1,2	3	Lecture & Problem solving
Module 2: Electrical Power, Energy, and Supply System				
Power – Active, reactive, and apparent.	2.1	1,2	3	Lecture
Electrical energy and calculation of electricity bills	2.2	2	3	Lecture & Problem solving
Efficiency, losses in electrical systems, and importance in energy saving	2.3	2,3	3	Lecture & Problem solving
Power factor – Concept and simple significance	2.4	2	3	Lecture
Overview of Electrical Supply System – Generation to distribution	2.5	2,5	3	Seminar/Group discussion
Module 3: Electrical Machines and Transformers				
Classification of electrical machines	3.1	1,2	3	Lecture
DC Machines – Construction, principle, and applications	3.2	3	3	Lecture
AC Motors – Types (single-phase and three-phase), uses in industry	3.3	3	3	Lecture
Transformers – Principle, types, and applications	3.4	3	3	Lecture
Comparison of motors used in renewable energy systems	3.5	5	3	Seminar/Group discussion
Introduction to alternators and their role in wind energy	3.6	5	3	Seminar/Group discussion
Module – 4 : Electrical Wiring, Safety, and Renewable Applications				
Types of wiring systems – Surface, conduit, and concealed wiring	4.1	3,2	3	Seminar/Group discussion
Electrical safety – Earthing, fuses, MCBs, safety devices	4.2	4	3	Lecture & Problem solving
Electrical symbols and simple wiring diagrams	4.3	3	3	Lecture & Problem solving
Introduction to solar system components – PV panels, inverters, batteries	4.4	4,5	3	Lecture
Role of electrical knowledge in solar and wind energy system installation	4.5	5	3	Seminar/Group discussion
Module 5: Teacher Specific Content				
<i>(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)</i>				
This content will be evaluated internally				

Textbook

1. V.K. Mehta & Rohit Mehta – Basic Electrical Engineering
2. D.P. Kothari & I.J. Nagrath – Basic Electrical Engineering
3. B.L. Theraja – Fundamentals of Electrical Engineering and Electronics

Reference

1. S.K. Bhattacharya, Basic Electrical and Electronics Engineering, Pearson Education, Latest Edition.



2. C.L. Wadhwa, Electrical Engineering, New Age International Publishers, Latest Edition.
3. H. Cotton, Advanced Electrical Technology, CBS Publishers, Reprint Edition (for deeper reference).
4. NPTEL Video Lectures and Modules – Basic Electrical Technology
5. Skill India e-Content – Electrician Trade Modules

Course Designed by Ms. Aswani B



SBU25RE2SDC101: SOLAR PHOTOVOLTAIC INSTALLATION

Type of Course	Major		
Course Level	100-199		
Credit	4		
Course Delivery Duration	Theory (Hrs)	Practical (Hrs)	Total (Hrs)
	45	30	75
Pre-requisite (if any)	None		

Course Outcomes

No.	Description	Cognitive Level
CO1	Install the civil and mechanical parts required for a Solar PV system.	A
CO2	Perform safe and efficient installation of rooftop and ground-mounted solar PV systems following standard procedures.	A
CO3	Conduct pre-commissioning and post-installation electrical testing using appropriate instruments.	An
CO4	Carry out routine operation and preventive maintenance activities to ensure optimal system performance.	U
CO5	Apply relevant safety measures and use personal protective equipment (PPE) during all phases of PV system installation and maintenance	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyze; E – Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2		3		1	2				1
CO2	1		2			1		1	1	2
CO3	2	2	3	1	1	1	1	2	1	1
CO4			1			2		1		
CO5	1		3		1		1	1		1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Viva	Assignments	Seminar/Group Discussion	Problem based assignments	Written test	
CO1	x					x
CO2	x				x	x
CO3	x	x			x	x
CO4	x	x		x		x
CO5	x		x			x

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Performance	Skill	Viva	Record	Model exam	
CO1	x	x	x	x	x	x
CO2	x	x	x	x	x	x
CO3	x	x	x	x	x	x
CO4			x	x	x	x
CO5			x	x	x	x



Course Content and Transaction Mechanism Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Install Civil and Mechanical Parts of Solar PV System				
Install Mounting System	1.1	1	2	Video Tutorials
Install Photovoltaic Module	1.2	1	2	Video Tutorials
Module Interconnection	1.3	1	3	Lecture
Install Electrical Components	1.4	2	2	Video Tutorials
Install Conduits and Cables	1.5	2	2	Video Tutorials
Get the Grounding Systems Installed	1.6	2	2	Video Tutorials
Install Battery Bank	1.7	2	2	Video Tutorials
Module 2: Test & Commission Solar PV System				
Tools and Accessories Required for Testing – Overall System Inspection	2.1	3	2	Group discussion
Testing of Solar Array	2.2	3	3	Video Tutorials
Wire and Earthing Continuity Tests	2.3	3	3	Lecture
Testing of Charge Controller and Batteries	2.4	3	3	Lecture
Start-up the System – Unintentional Islanding Functionality Tests	2.5	3	2	Lecture
Sample Test and Commission Record Sheet	2.6	3	2	Lecture
Module 3: Troubleshooting, Maintenance and Safety hazards				
Preventive Maintenance of PV System	3.1	4	2	Lecture
Troubleshooting and Maintenance	3.2	4	3	Lecture
Establish and Follow Safe Work Procedure	3.3	5	3	Lecture
Use and Maintain Personal Protective Equipment (PPE)	3.4	5	2	Group discussion
Identification and Mitigation of Safety Hazards, Work, Health and safety	3.5	5	3	Group discussion
Customer Orientation for a Solar PV System	3.6	5	2	Group discussion
Module 4: Teacher Specific Content (This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned). This content will be evaluated internally				

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 5				
Module Interconnection	1	1	6	Lab Session / Practical
Series and Parallel Connection of PV modules	2	2	6	Lab Session / Practical
Testing of a Solar PV system	3	3	6	Lab Session / Practical
Operation and Maintenance of a Solar PV system	4	4	6	Lab Session / Practical
Identification and mitigation of safety hazards	5	5	6	Classroom activity/ Group discussion



Textbooks

1. Solar PV Installer (Suryamitra) Participant Handbook
2. Non-conventional Energy Sources and Utilization (Energy Engineering); R. K. Rajput; 2012; 1st Edition.; S. Chand & Company Ltd.

Course designed by Anoop A



SBU25RE2SDC102: BASIC ELECTRONICS

Type of Course	Major		
Course Level	100-199		
Credit	4		
Course Delivery	Theory (Hrs)	Practical (Hrs)	Total (Hrs)
Duration	45	30	75
Pre-requisite (if any)	Basic Physics and Mathematics		

Course Outcomes

No.	Description	Cognitive Level
CO1	Understand theoretical concepts to interpret experimental data, troubleshoot circuits, and document findings effectively in laboratory settings.	U
CO2	Understand the construction, operation, and characteristics of semiconductor diodes and apply them in basic rectifier, filter and voltage stabilizer circuits.	U
CO3	Understand the working principles of BJTs and design simple amplifier and switching circuits using transistors.	U
CO4	Understand the operation and applications of basic power electronic devices such as JFET and MOSFET.	U
CO5	Apply practical skills in assembling and testing electronic circuits using diodes, transistors, and power electronic components.	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1		1	1		1		1		
CO2	1		1	1		1		1		
CO3	1		1	1		1		1		
CO4	1		1	1		1		1		
CO5	1		1	1		1		1		

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Viva voce	Home Assignments	Oral Presentation	Problem based assignments	Written test	
CO1	x		x		x	x
CO2	x	x	x	x	x	x
CO3	x	x	x	x	x	x
CO4	x	x	x	x	x	x

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Punctuality	Observation of practical Skill	Viva voce	Record	Model exam	
CO5	x	x	x	x	x	x



Course Content & Transaction Mechanism Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Diodes				
Bohr model of atom	1.1	1,2	1	Lecture
bonds in semiconductors, n-type material, p-type material	1.2	1,2	2	Lecture
p-n junction, V-I characteristics of p-n junction	1.3	1,2	1	Lecture
solar cells as diodes, LED - Principle - characteristics (V-I and light current) applications, advantages	1.4	1,2	3	Lecture
diode as rectifier, half wave rectifier, full wave rectifier (center tap and)	1.5	1,2	3	Lecture
types of filter circuits	1.6	1,2	3	Lecture
Voltage stabilization - zener diode- Zener diode as voltage stabilizer.	1.7	1,2	2	Lecture
Module 2: Transistors				
Transistors-Bipolar junction transistors - Introduction	2.1	1,3	1	Lecture
naming of transistor terminals -	2.2	1,3	1	Lecture
transistor symbols	2.3	1,3	1	Lecture
transistor action	2.4	1,3	2	Lecture
Common emitter, common base and common collector configurations and their characteristics	2.5	1,3	5	Lecture
Transistor as a switch and amplifier (concept only)	2.6	1,3	2	Lecture
Basic use in solar charge controllers and inverters	2.7	1,3	3	Lecture
Module 3: Power Electronics				
Power Electronics- Introduction	3.1	1,4	1	Lecture
Types of FET	3.2	1,4	1	Lecture
Junction FET (JFET)- Formation of depletion region- Operation	3.3	1,4	2	Lecture
JFET-Characteristics- Drain Characteristics - Transfer characteristics	3.4	1,4	2	Assignment
JFET parameters	3.5	1,4	1	Lecture
MOSFET Types	3.6	1,4	2	Lecture
Depletion type-Enhancement type	3.7		2	Seminar
Module 4: Teacher Specific Content (This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned) This content will be evaluated internally				

References

1. V. K. Mehta, *Principles of Electronics*; 2006, Tenth Edition; S. Chand & Co.
2. R.S. Sedha, *A Textbook of Applied Electronics*; 2005, S. Chand and Co.
3. Donald A. Neamen, *Microelectronics: Circuit Analysis and Design*; McGraw-Hill
4. S. Salivahanan, *Electronic Devices and Circuits*, McGraw-Hill
5. Muhammad H. Rashid, *Power Electronics: Circuits, Devices and Applications*, Pearson
6. Bimbira P.S. *Power Electronics*; Khanna Publishers
7. Mohan, Undeland, Robbins, *Power Electronics: Converters, Applications and Design*, Wiley



Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 5				
Zener Diode characteristics	1	1	5	Lab Session / Practical
PN Junction Diode	2	2	5	Lab Session / Practical
Half Wave rectifier	3	4	5	Lab Session / Practical
Full Wave Rectifier	4	3	5	Lab Session / Practical
LED Characteristics	5	4	5	Lab Session / Practical
PN junction Diode Characteristics	6	5	5	Classroom activity/ Group discussion

References

1. V. K. Mehta, Principles of Electronics; 2006, Tenth Edition; S. Chand & Co.
2. R.S. Sedha, A Textbook of Applied Electronics; 2005, S. Chand and Co.

Course Designed by: Dr Subin P John



SBU25RE2MDC100: RENEWABLE ENERGY SOURCES

Type of Course	Multi – Disciplinary Course		
Course Level	100-199		
Credit	3		
Course Delivery Duration	Theory (Hrs)	Practical (Hrs)	Total (Hrs)
	30	30	60
Pre-requisite (if any)	None		

Course Outcomes

No.	Description	Cognitive Level
CO1	Describe different renewable energy sources and their importance in sustainable development.	U
CO2	Explain the basic working principles of solar, wind, biomass, hydro, and other renewable systems.	U
CO3	Compare renewable and non-renewable energy systems in terms of efficiency, cost, and environmental impact.	U
CO4	Identify real-life applications of renewable energy in different sectors.	U
CO5	Demonstrate basic skills in handling renewable energy devices and measuring their performance.	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E – Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2		1	1		3				
CO2	3		1			2		1	1	
CO3	2	1		2		1	1	1		
CO4	1		2	1		1	1	1	1	
CO5			1		1	2		2		3

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Viva	Assignments	Seminar/Group Discussion	Problem based assignments	Written test	
CO1	x			x	x	x
CO2	x	x		x	x	x
CO3	x	x		x	x	x
CO4	x	x	x	x	x	x
CO5	x			x	x	x

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Performance	Skill	Viva	Record	Model exam	
CO1			x	x	x	x
CO2			x	x	x	x
CO3			x	x	x	x
CO4			x	x	x	x
CO5	x	x	x	x	x	x



Course Content and Transaction Mechanism Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1 : Fundamentals of Renewable Energy Sources				
Energy crisis and the need for renewables	1.1	1	2	Lecture
Overview of Solar Energy: PV and Thermal	1.2	2	3	Lecture
Basics of Wind Energy	1.3	2	3	Lecture
Biomass energy and Biogas technology	1.4	2	3	Lecture
Hydropower (small and micro-hydro)	1.5	2	3	Lecture
Comparative analysis: RE vs fossil fuels	1.6	3	2	Lecture
Module 2				
Geothermal Energy	2.1	2	3	Lecture
Ocean Energy	2.2	2	3	Lecture
Hydrogen as an Energy Carrier	2.3	2	2	Lecture
Waste-to-Energy	2.4	4	2	Lecture
Energy Storage	2.5	4	2	Lecture
Barriers and future trends in Renewable energy adoption	2.6	4	2	Lecture
Module 3: Teacher Specific Content (This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned) This content will be evaluated internally				

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 4				
Familiarization of Solar Measuring Instruments	4.1	5	6	Lab/ Practical Session
Familiarization of Wind Energy Conversion Device	4.2	5	6	Lab/ Practical Session
Group Discussion based on Conventional and Non – Conventional Energy Sources	4.3	5	6	Group Discussion
Feasibility study for installing a Solar PV power plant	4.4	5	6	Site Study
Life cycle cost analysis of a Solar PV system	4.5	5	6	Assignment

Reference and Textbooks

1. Non-conventional energy sources; G. D. Rai; 2011; Fifth Edition, Khanna Publishers
2. Non-conventional Energy Sources and Utilization (Energy Engineering); R. K. Rajput; 2012; 1st Edition.; S. Chand & Company Ltd.

Course designed by Anoop A



SBU25RE2OJT01: ON THE JOB TRAINING 2

Type of Course	SDC/Major		
Course Level			
Credit	2		
Course Delivery Duration	Theory (Hrs)	Practical (Hrs)	Total (Hrs)
		75	75
Pre-requisite (if any)	OJT should demonstrate progressive advancement in relevant field with exposure and skill application over successive semesters.		

Course Outcomes

No.	Description	Cognitive Level
CO1	Demonstrate understanding of industry operations, standards, and professional expectations through direct exposure to workplace environments.	Understand
CO2	Apply job-specific skills effectively in real-world tasks and responsibilities within the assigned industry setting.	Apply
CO3	Integrate academic knowledge with practical applications to solve work-related challenges and contribute to organizational goals.	Analyse
CO4	Exhibit essential workplace competencies such as punctuality, accountability, communication, teamwork, and adaptability.	Apply
CO5	Identify and evaluate potential career opportunities by reflecting on their internship experiences and professional interactions.	Evaluate

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E – Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1		1		3	1	2	1	1	
CO2	2	1	2		3	3		2	1	1
CO3	1		1	1	3			3		
CO4			2		3	1	1	2	2	1
CO5	1		1		3	2		1	1	

Course designed by Anoop A



SEMESTER III

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
SBU25RE3SDC200	SDC/Major	Energy Conservation, Management and Auditing	4	60	4
SBU25RE3SDC201	SDC/Major	Material Science	5	75	4
SBU25RE3SDC202	SDC/Major	Wind power technology	5	75	4
SBU25RE3OJT01	SDC/Major	On the Job Training 3	5	75	2



SBU25RE3SDC200: ENERGY CONSERVATION, MANAGEMENT AND AUDITING

Type of Course	Skill Development Course		
Course Level	200-299		
Credit	4		
Course Delivery Duration	Theory (Hrs) 60	Practical (Hrs) 0	Total (Hrs) 60
Pre-requisite (if any)	None		

Course Outcomes

No.	Description	Cognitive Level
CO1	Understand the importance of energy conservation and energy conservation act and its features.	U
CO2	Describe about Management of energy conservation methods	U
CO3	Understand energy conservation in housing and commercial building	U
CO4	Understand about energy conservation methods in electrical systems.	U
CO5	Understand about energy conservation methods in thermal systems.	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	1	1		1		2	2		1	
CO2	1	1		1		1	1	1	1	
CO3	1	1	2	1			1	1	1	
CO4	1	1		1		1		1	2	
CO5	1	1		1		1	1	1	3	

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Viva	Assignments	Seminar/Group Discussion	MCQs	Written test	
CO1	x				x	x
CO2	x		x		x	x
CO3	x			x	x	x
CO4	x	x		x	x	x
CO5	x	x		x	x	x

Course Content & Transaction Mechanism (Theory)

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Energy conservation, Waste Minimization & Resource Conservation (15 Hrs)				
Energy Conservation & Its Importance	1.1	1	2	Lecture
Overview of energy conservation principles. Significance of energy conservation in sustainable development	1.2	1	2	Lecture



The Energy Conservation Act, 2001, Key features and objectives of the Act. Role of Bureau of Energy Efficiency (BEE).	1.3	1	2	Lecture
Waste Minimization & Resource Conservation. Need for waste minimization. Methods and classification of waste minimization. Effects of waste on the environment.	1.4	1	2	Lecture
Role of pollution control boards.	1.5	1	2	Lecture
Case studies on successful waste minimization.	1.6	1	2	Lecture
Energy Scenario: Current energy sources and their distribution, Energy consumption patterns.	1.7	1	2	Lecture
Energy policies and pricing reforms. Energy security and future strategies.	1.8	1	1	Lecture
Module 2: Energy Management and Audit Techniques (15 Hrs)				
Energy Management & Audit - Definition and Objective of Energy Management - Principle of Energy Management - Energy Management skills - Energy Management Strategies Energy Audit - Types & Methodology - Energy Audit Reporting format Matching energy usage to requirement	2.2	2	1	Seminar/ Group discussion
Energy Audit Instruments - Principal and working of Electrical Measuring Instruments Voltmeter, ammeter, Power Factor meter, Tri-vector meters for Speedometer contact /non-contact type	2.3	3	2	Seminar/ Group discussion
Flue gas analyzer, Principal of measurements by Chemical Methods	2.4	3	3	Seminar/ Group discussion
Electronic Methods	2.5	3	2	Seminar/ Group discussion
Temperature Measurement- Contact type methods, Non-Contact type methods	2.6	3	3	Seminar/ Group discussion
Pressure and velocity Measurement (Bourdon gauge, Manometers, Anemometer)	2.7	3	2	Seminar/ Group discussion
Flow Measurement of steam, water and air -Humidity Measurement and leak Detectors	2.8	3	2	Seminar/ Group discussion
Module 3: Energy Conservation Methods in Electrical System (15 Hrs)				
Energy wastage issues	3.1	4	2	Lecture
Energy conservation in motors and drives.	3.2	4	1	Lecture
Power factor improvement techniques.	3.3	4	3	Lecture
Effects of harmonics and mitigation methods.	3.4	4	1	Lecture
Variable Speed Drives (VSD) and their applications.	3.5	4	2	Lecture
Energy conservation in electric furnaces. Pumps, Compressors, Fans & Blower	3.6	4	2	Lecture
Energy conservation in boilers and steam systems.	3.7	4	1	Lecture
Heat recovery and insulation techniques. Condensate recovery systems.	3.8	4	3	Lecture
MODULE 4: Energy Conservation in Thermal System (15 Hrs)				
Boiler - Steam distribution system HVAC	4.1	5	3	Lecture
Waste heat recovery	4.2	5	2	Lecture
Insulation of pipes	4.3	5	2	Lecture
Condensate recovery	4.4	5	3	Lecture
Fuel Handling	4.5	5	2	Lecture



Other heat-based application Case Study	4.6	5	3	Lecture
Module 5: Teacher Specific Content (This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned) This content will be evaluated internally				

Textbooks

1. Energy Conservation in the Chemical & Allied Industries by S.K. Awasthi, 1989, South Asian Publishers, New Delhi
2. Energy Management Handbook by Wayne C. Turner, 2001, Fairmont Press.

Reference

1. General Aspects of Energy Management & Energy Audit, Bureau of Energy Efficiency
2. Industrial Energy Conservation by Melvin H. Chiogioji, 1979, M. Dekker.

Course designed by Anju A



SBU25RE3SDC201: MATERIAL SCIENCE

Type of Course	SDC/Major		
Course Level	200-299		
Credit	4		
Course Delivery Duration	Theory (Hrs)	Practical (Hrs)	Total (Hrs)
	45	30	75
Pre-requisite (if any)	Basic knowledge of material science at the 12th grade level.		

Course Outcomes

No.	Description	Cognitive Level
CO1	Understand basic and detailed knowledge on nanoscience and nanomaterials.	U
CO2	Understand in detail the various applications of nanomaterials.	U
CO3	Remember different preparation methods and applications of various polymer.	R
CO4	Understand different thin film fabrication method	U
CO5	Apply experimental skills and analyse the process and outcomes of an experiment quantitatively and qualitatively.	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	1	1				2	2		1	
CO2	1	1				1	1		1	
CO3	1					1				
CO4	1	1				1	1		1	
CO5	1	1		1		1		1	3	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Viva	Assignments	Seminar/ Group Discussion	Problem based assignments	Written test	
CO1	x				x	x
CO2	x				x	x
CO3	x		x		x	x
CO4	x	x		x	x	x
CO5					x	x

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Performance	Skill	Viva	Record	Model exam	
CO1						
CO2						
CO3						
CO4						
CO5	x	x	x	x	x	x



Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Nanomaterials in Solar Energy Systems (15 Hrs)				
Classification and properties of nanomaterials	1.1	1	3	Lecture
Synthesis methods: Bottom-up and top-down approaches	1.2	1	3	Lecture
Applications in Solar Cells:	1.3	1	2	Lecture
Nanostructures: Nanowires, nanotubes, nanorods, quantum dots	1.4	2	2	Lecture
Integration into various solar cell technologies: Crystalline silicon, organic, dye-sensitized, and perovskite solar cells	1.5	2	2	Lecture
Nanomaterials in Fuel Cells: Application in proton exchange membrane fuel cells (PEMFC) and solid oxide fuel cells (SOFC) Impact on catalyst performance and durability	1.6	2	3	Lecture
Module 2: Nanomaterials in Energy Storage and Conversion (15 Hrs)				
Thin Film Deposition Techniques: Physical methods: Introduction	2.1	4	1	Lecture
Vacuum evaporation, electron beam evaporation, flash evaporation	2.2	4	2	Lecture
Sputtering	2.3	4	2	Lecture
Chemical methods	2.4	4	2	Lecture
Electroplating, chemical bath deposition, spray pyrolysis	2.5	4	2	Lecture
Comparison of methods: Advantages and limitations	2.6	4	2	Lecture
Thin films in solar cells: Materials and performance. Role in enhancing efficiency and reducing costs	2.7	2	3	Lecture
Challenges in large-scale production and integration	2.8	2	1	Lecture
Polymer Fundamentals: Introduction	3.1	3	5	Lecture
Classification: Natural, synthetic; linear, cross-linked; plastics, elastomers, fibers	3.2	3	5	Lecture
Polymerization reactions and examples: Polyethylene, polypropylene, PVC, polyester	3.3	3	3	Lecture
Natural rubber: Structure and vulcanization; synthetic rubbers: SBR, nitrile rubber, neoprene	3.4	3	2	Lecture
Module 4: Teacher Specific Content <i>(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)</i> This content will be evaluated internally				

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 5				
Understand how anti-reflective coatings improve solar panel efficiency.	1	5	6	Activity
Study how PCMs (e.g., paraffin wax) store and release heat.	2	5	6	Activity
Understand the material structure and function of each solar cell layer.	3	5	6	Assignment



Identify different materials used in wind turbine construction and explain why they are chosen.	4	5	6	Assignment
Understand the function and structure of materials in energy storage.	5	5	6	Activity

Textbooks

1. Thin film Phenomena; K L Chopra; 1969; McGraw Hill.
2. Handbook of Thin film technology; L. I. Meissel& R. Glang; 1970; McGraw Hill.
3. Nano materials for sustainable energy, ed. Quan Li, Springer, 2016, ISBN 978 3319320212
4. Advanced nanomaterials and their applications in renewable energy, Jingbo Louise, Liu and Sajid Bashir, Elsevier, ISBN 9780128015285

Course Designed by Anju A



SBU25RE3SDC202: WIND POWER TECHNOLOGY

Type of Course	Major		
Course Level	200-299		
Credit	4		
Course Delivery Duration	Theory (Hrs)	Practical (Hrs)	Total (Hrs)
	45	30	75
Pre-requisite (if any)	Nil		

Course Outcomes

No.	Description	Cognitive Level
CO1	Discuss the history of wind energy, its current and future prospects.	U
CO2	Understand about various causes of wind, its measurement and distribution	U
CO3	Explain about aerodynamics of wind turbine, its power regulation	A
CO4	Describe about various turbines, wind energy conversion system component	U
CO5	Learn to analyse data and optimize wind turbine performance.	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	1	1				1	1			
CO2	1	1				1	1			
CO3	1	1		1				2	1	
CO4	1	1				1	1			
CO5	1			1	1			1	3	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Viva	Assignments	Seminar/ Group Discussion	Problem based assignments	Written test	
CO1	x				x	x
CO2	x				x	x
CO3	x		x		x	x
CO4	x	x		x	x	x
CO5					x	x

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Performance	Skill	Viva	Record	Model exam	
CO1						
CO2						
CO3						
CO4						
CO5	x	x	x	x	x	x



Course Content & Transaction Mechanism Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1				
History of wind energy, Current status and future prospects, Wind Energy in India Environmental benefits of wind energy	1.1	1	3	Lecture, infographic analysis, discussion
Power available in the wind - Wind Turbine power and Torque characteristics	1.2	2	3	Lecture with numerical examples, chalk-talk
Types of rotors: Horizontal and Vertical axis wind turbine - Characteristics of wind rotor	1.3	3	3	Diagrams, comparative analysis, video clips
Analysis of wind regimes - Local effects, wind shear, turbulence and acceleration effects	1.4	2	2	Case discussion, simulation-based demo
Measurement of wind: Ecological indicator, Anemometers	1.5	2	2	Demonstration, models, real-time visuals
Wind direction - Wind speed statistics: Time and Frequency Environmental concerns and problems caused by wind projects	1.6	2	2	Graphical interpretation, hands-on activity
Module 2: Aerodynamics of Wind Turbine				
Airfoil, lift and drag characteristics	2.1	3	3	Diagram-based teaching, animation, Q&A
Aerodynamic theories	2.2	3	3	Lecture, flow visualization, group discussion
Axial momentum theory	2.3	3	3	Step-by-step derivation, problem-solving
Power coefficient and tip speed ratio characteristics	2.4	3	2	Graph plotting, numerical examples
Rotor design and performance analysis	2.5	5	2	Case study, examples, visual aids
Power curve of wind turbine	2.6	3	2	Interactive chart
Module 3: Wind Energy Conversion Systems				
Introduction to wind electric generators	3.1	4	2	Group discussion/Seminar
Generators types, Induction and synchronous	3.2	4	2	Group discussion/Seminar
Role of rotor in electricity generation	3.3	4	2	Group



				discussion/Seminar
Introduction to gearbox and working	3.4	4	1	Group discussion/Seminar
Types of towers and their role in wind systems	3.5	4	2	Group discussion/Seminar
Power control in wind turbines – simple explanation	3.6	4	1	Group discussion/Seminar
Basic safety features in wind turbines	3.7	4	2	Group discussion/Seminar
Applications: Wind pumps, piston pumps – basic concepts and uses	3.8	5	3	Group discussion/Seminar

Module 4: Teacher Specific Content

(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)

This content will be evaluated internally

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 5: Wind Energy and Fluid Mechanics (30 Hrs)				
Surface tension – Capillary rise method	5.1	5	6	Demonstration and peer learning
Density of a liquid – Constant Pressure Head Method	5.2	5	4	Demonstration and peer learning
Measurement of wind speed	5.3	5	4	Demonstration and peer learning
I–V characteristics of wind turbine at different wind speeds	5.4	5	4	Demonstration and peer learning
P, V and F measurement of output of wind generator	5.6	5	4	Demonstration and peer learning
Efficiency of charge controller	5.7	5	4	Demonstration and peer learning
Evaluation of cut-in speed	5.8	5	4	Demonstration and peer learning
Surface tension – Capillary rise method	5.1	5	6	Demonstration and peer learning

Textbook

1. Wind Energy: Fundamentals, Resource Analysis and Economics; Mathew Sathyajith; 2006, Springer III-9

Reference

1. Johnson GL. Wind Energy Systems, 2006, Electronic Edition, Prentice Hall Inc
2. Burton T. Sharpe D. Jenkins N. Bossanyi E. 2001, Wind Energy Handbook. John Wiley
3. Jha AR. Wind Turbine Technology, 2011, CRC Press, Taylor & Francis
4. Jain P. Wind Energy Engineering, 2011, McGraw-Hill

Course Designed by Anju A



SBU25RE3OJT01: ON THE JOB TRAINING 3

Type of Course	SDC/Major		
Course Level			
Credit	2		
Course Delivery Duration	Theory (Hrs)	Practical (Hrs)	Total (Hrs)
		75	75
Pre-requisite (if any)	OJT should demonstrate progressive advancement in relevant field with exposure and skill application over successive semesters.		

Course Outcomes

No.	Description	Cognitive Level
CO1	Demonstrate understanding of industry operations, standards, and professional expectations through direct exposure to workplace environments.	Understand
CO2	Apply job-specific skills effectively in real-world tasks and responsibilities within the assigned industry setting.	Apply
CO3	Integrate academic knowledge with practical applications to solve work-related challenges and contribute to organizational goals.	Analyse
CO4	Exhibit essential workplace competencies such as punctuality, accountability, communication, teamwork, and adaptability.	Apply
CO5	Identify and evaluate potential career opportunities by reflecting on their internship experiences and professional interactions.	Evaluate

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E – Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1		1		3	1	2	1	1	
CO2	2	1	2		3	3		2	1	1
CO3	1		1	1	3			3		
CO4			2		3	1	1	2	2	1
CO5	1		1		3	2		1	1	

Course designed by **Anoop A**



SEMESTER IV

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
SBU25RE4SDC200	SDC/Major	Project Management	4	60	4
SBU25RE4SDC201	SDC/Major	Hydro Power System and Ocean Energy	5	75	4
SBU25RE4SDC202	SDC/Major	Solar Photovoltaic Designing	5	75	4
SBU25RE2INT	SDC/Major	Internship (20 days on Sem Break)	-	2	
SBU25RE4SEC200	GEC/ Foundation	Entrepreneurship Skills	3	45	3
SBU25RE4VAC200	GEC/ Foundation	Environmental Studies and Human Rights	3	45	3



SBU25RE4SDC200: PROJECT MANAGEMENT

Type of Course	Skill Development Course		
Course Level	200-299		
Credit	4		
Course Delivery Duration	Theory (Hrs)	Practical (Hrs)	Total (Hrs)
	60	0	60
Pre-requisite (if any)	None		

Course Outcomes

No.	Description	Cognitive Level
CO1	Explain project management principles and apply planning techniques like scope, scheduling, and cost estimation.	U
CO2	Develop and implement project plans using tools for scheduling, budgeting, and performance tracking.	U
CO3	Apply strategies for managing project teams, including communication, leadership, and conflict resolution.	A
CO4	Monitor project execution and analyse progress using standard project control techniques.	A
CO5	Complete project closure by preparing reports, documenting outcomes, and ensuring stakeholder satisfaction.	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	1	2			1	1	1		
CO2		1	1		1	1		2	2	
CO3	2	1	1		1	1		3		1
CO4			1	2				1	1	1
CO5				1	1				3	

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Viva	Assignments	Seminar/Group Discussion	MCQs	Written test	
CO1	x				x	x
CO2	x	x	x		x	x
CO3	x			x	x	x
CO4	x		x	x	x	x
CO5	x			x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1 : Project Management and Planning				
Introduction to Project Management (Definitions, Characteristics, Life Cycle)	1.1	1	4	Lecture



Phases of a project / Project life cycles	1.2	1	2	Lecture
Project Planning	1.3	1	2	Lecture
Work Breakdown Structure (WBS)	1.4	1	2	Lecture
Time and Cost Estimation Techniques	1.5	1	2	Lecture
Project Scheduling Tools (Gantt Charts, CPM, PERT)	1.6	1	3	Lecture
Module 2: Project Implementation and Monitoring				
Project resources – Human, Materials and Finance	2.1	2	3	Seminar/ Group discussion
Project network techniques	2.2	4	3	Seminar/ Group discussion
Planning for monitoring and evaluation – Project audits	2.3	4	3	Seminar/ Group discussion
Project Management Information Systems	2.4	2	2	Seminar/ Group discussion
PERT and CPM	2.5	2	2	Seminar/ Group discussion
Project communication – Post project reviews	2.6	2	2	Seminar/ Group discussion
Module 3: Project Team Management				
Roles and Responsibilities of Project Team Members	3.1	3	2	Group discussion
Project team management	3.2	3	3	Group discussion
Human resources – Organizing- Recruiting	3.3	3	2	Lecture
Contracts – Negotiations	3.4	3	2	Lecture
Project organizations	3.5	3	4	Lecture
Team Performance Monitoring and Feedback	3.6	3	2	Lecture
Module 4: Closing the Project				
Project termination	4.1	5	3	Lecture
Termination procedures	4.2	5	3	Lecture
Strategic implications – Project in trouble	4.3	5	2	Lecture
Evaluation of termination possibilities	4.4	5	3	Lecture
Project Inventory management	4.5	5	3	Lecture
Supply and transportation of materials	4.6	5	1	Lecture
Module 5: Teacher Specific Content				
(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)				
This content will be evaluated internally				

Reference

1. Project Management - for 21st Century-Bennet P Lientz, Kathryn Rea, 1995, Academic Press.
2. The Essentials of Project Management-Dennis Lock, 2014, Gower Publishing Ltd.
3. Project Management - David I Cleland, 1999, Mcgraw Hill International Edition.
4. Project Management-Harvey, 2009, Maylor-Pearson Publication.

Course designed by Anoop A



SBU25RE4SDC201: HYDROPOWER AND OCEAN ENERGY SYSTEMS

Type of Course	Major		
Course Level	200-299		
Credit	4		
Course Delivery Duration	Theory (Hrs)	Practical (Hrs)	Total (Hrs)
	45	15	60
Pre-requisite (if any)	Basic Physics and Mathematics		

Course Outcomes

No.	Description	Cognitive Level
CO1	Understand the principles, components, and influential factors of hydropower and ocean energy systems.	U
CO2	Understand the working principles and components of hydropower systems.	U
CO3	Analyse the technical and environmental factors that influence the selection of sites and technologies for hydro and ocean energy projects.	An
CO4	Understand the working principles and components of ocean energy systems.	U
CO5	Analyse the basic model of a small-scale hydropower or ocean energy system and present a feasibility report.	An

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E – Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	2				1				
CO2	2	2				1				
CO3	2	2				1				
CO4	2	2				1				
CO5	2	2				1				

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Viva voce	Home Assignments	Oral Presentation	Problem based assignments	Written test	
CO1	x		x	x	x	x
CO2	x	x	x	x	x	x
CO3	x	x	x	x	x	x
CO4	x	x	x	x	x	x
CO5	x				x	x

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Group tutorial work	Oral Presentation	Viva voce	Case study	Team project report	
CO1		x	x			x
CO2		x	x			x
CO3		x	x			x
CO4		x	x			x
CO5	x	x	x	x	x	x



Course Content & Transaction Mechanism Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Hydropower – Principles and Systems				
Introduction to Hydropower: History, current status, and potential (global and India)	1.1	1,2	1	Lecture
Classification of Hydropower Plants: Large, small, micro, mini; run-of-river vs. storage	1.2	1,2	2	Lecture
Hydropower Plant Components: Dam, intake, penstock, surge tank, spillway Turbines (Pelton, Francis, Kaplan) – working principles and selection criteria	1.3	1,2	6	Lecture
Hydraulic Concepts: Head, flow rate, efficiency, power calculation	1.4	1,2	3	Lecture
Hydrological assessment: Flow-duration curves, rainfall-runoff relationship	1.5	1,2	3	Lecture
Module 2: Hydropower – Planning, Design, and Integration				
Site selection and feasibility analysis	2.1	1,3	2	Lecture
Turbine and generator selection: Design criteria	2.2	1,3	5	Lecture
Civil works: Layout of hydropower stations, structural considerations	2.3	1,3	2	Lecture
Environmental and social impacts: Reservoir-induced effects, mitigation	2.4	1,3	1	Lecture
Economic evaluation: Capital cost, operational costs, payback period	2.5	1,3	2	Lecture
Grid integration and load management	2.6	1,3	2	Lecture
Policies and incentives related to small hydropower in India	2.7	1,3	1	Seminar
Module 3: Ocean Energy Technologies				
Overview of Ocean Energy: Resource potential – wave, tidal, OTEC, salinity gradient	3.1	1,4	2	Lecture
Wave Energy: Wave mechanics, point absorbers, oscillating water column systems	3.2	1,4	3	Lecture
Tidal Energy: Tidal range vs. tidal stream, tidal barrages, turbines, lagoons	3.3	1,4	3	Lecture
Ocean Thermal Energy Conversion (OTEC): Working of open and closed cycles	3.4	1,4	2	Lecture
Environmental concerns and site constraints	3.5	1,4	2	Lecture
Emerging technologies and global developments	3.6	1,4	2	Lecture
Future scope and challenges of ocean energy in India	3.7	1,4	1	Assignment
Module 4: Teacher Specific Content <i>(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)</i> This content will be evaluated internally				

References

1. *Hydropower Engineering* by C.C. Warnick
2. MNRE and CEA Reports (India-specific)



3. Renewable Energy Engineering and Technology by VVN Kishore (TERI Press)
4. Energy Systems Engineering by Vanek and Albright
5. Ocean Energy: Tide and Tidal Power by R.H. Clark
6. IEA-OES Reports and Technical Briefs

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 5				
Case study analysis: Small hydro and tidal projects (Indian and global)	1	1,2,3,4,5	6	Case study
Group project: Design a small hydropower system for a rural area	2	1,2,5	6	Small project
Feasibility study for a wave/tidal energy site	3	1,4,5	6	Site visit
Visit to a small hydro project or water flow testing facility	4	1,2,5	6	Site visit
Report writing and seminar presentation	5	1,2,3,4,5	6	Report writing

Course Designed by: Dr Subin P John



SBU25RE4SDC202: SOLAR PHOTOVOLTAIC DESIGNING

Type of Course	SDC/Major		
Course Level	200-299		
Credit	4		
Course Delivery Duration	Theory (Hrs)	Practical (Hrs)	Total (Hrs)
	45	30	75
Pre-requisite (if any)	Fundamentals of Solar Photovoltaics and Electrical Connections		

Course Outcomes

No.	Description	Cognitive Level
CO1	Identify and classify various types of solar PV systems based on application and configuration.	U
CO2	Explain the structure and functioning of solar PV arrays and how they influence system performance.	U
CO3	Demonstrate series and parallel connections of PV modules and calculate resulting voltage, current, and power.	U
CO4	Design off-grid, on-grid, and hybrid PV systems based on energy demand and system requirements.	A
CO5	Compare the advantages and limitations of different PV system types and recommend suitable configurations.	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1		2	1		2			1	1
CO2	2		3	1		2		1		
CO3	1			1		1				1
CO4	2	2	3	2	1	1	1	2	1	1
CO5	1		2	2		2				1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Viva	Assignments	Seminar/ Group Discussion	Problem based assignments	Written test	
CO1	x		x		x	x
CO2	x				x	x
CO3	x				x	x
CO4	x	x		x	x	x
CO5	x	x			x	x

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Performance	Skill	Viva	Record	Model exam	
CO1			x	x	x	x
CO2	x		x	x	x	x
CO3			x		x	x
CO4	x	x	x		x	x
CO5			x		x	x



Course Content & Transaction Mechanism Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Types of Solar Photovoltaic Systems				
Introduction to Types of Solar Photovoltaic systems	1.1	1	3	Lecture
Grid Connected Solar systems	1.2	1	3	Seminar/ Group discussion
Standalone Solar systems	1.3	1	3	Seminar/ Group discussion
Hybrid Solar systems	1.4	1	3	Seminar/ Group discussion
Comparison of Different types of solar systems	1.5	5	3	Lecture
Module 2: Solar PV Arrays				
Standard PV module parameters	2.1	2	2	Lecture
Connection of Modules in Series Combination	2.2	3	3	Lecture
Connection of Modules in Parallel Combination	2.3	3	3	Lecture
Connection of Modules in Series and Parallel (Mixed Combination)	2.4	3	2	Lecture
Mismatch in Series connection	2.5	3	2	Lecture
Mismatch in Parallel connection	2.6	3	3	Lecture
Module 3: Design Methodology				
Configuration of Grid-connected Solar PV Systems	3.1	4	3	Lecture
Components of Solar PV systems	3.2	4	3	Lecture
Design Methodology for Grid Connected SPV System	3.3	4	3	Lecture
Design Methodology for Standalone SPV System	3.4	4	3	Lecture
Hybrid Solar Photovoltaic systems	3.5	4	3	Lecture
Module 4: Teacher Specific Content				
(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)				
This content will be evaluated internally				

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 5				
Drawing a Simple Solar PV Single Line Diagram (SLD)	1	2	6	Assignment
Load Estimation and Energy Demand Calculation	2	4	6	Assignment
PVsyst software to model a basic grid-tied PV system.	3	4	6	Lab/ Practical
System Sizing for Grid Connected PV System	4	1	6	Assignment
System Sizing for Standalone PV System	5	1	6	Assignment

Reference

1. Solar PV Installer (Suryamitra) Participant Handbook
2. Solar Photovoltaic Technology and Systems: A manual for Technicians, Trainers and



Engineers, Chetan Singh Solanki, 2013, PHI Learning Pvt.

Course Designed by Anoop A



SBU25RE4SEC200: ENTREPRENEURSHIP SKILLS

Type of course	Skill Enhancement Course		
Course Level	200 – 299		
Credit	3		
Course Delivery Duration	Theory (Hrs)	Practical (Hrs)	Total (Hrs)
	45	0	45
Pre-requisite (if any)	None		

Course Outcomes

No.	Description	Cognitive Level
CO1	Identify entrepreneurial qualities and assess the role of entrepreneurship in economic development.	U
CO2	Generate, screen, and select feasible business ideas based on creativity and market need.	An
CO3	Develop a basic business model using structured tools.	A
CO4	Apply fundamental knowledge of business planning, marketing, and financial estimation.	A
CO5	Demonstrate effective communication, teamwork, and presentation skills through startup project work.	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1		1		2	2	1	1	1	
CO2	2								2	
CO3	1					2	1	1		3
CO4			1		2		2	3		
CO5					2	1		2		1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Viva	Assignments	Seminar	Problem based assignments	Written test	
CO1	x				x	x
CO2	x	x			x	x
CO3	x	x		x	x	x
CO4	x		x	x	x	x
CO5	x		x		x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Entrepreneurial Foundations and Idea Development				
Introduction to entrepreneurship (Meaning and importance)	1.1	1	3	Lecture
Traits of a successful entrepreneur	1.2	1	2	Lecture
Creativity and innovation in entrepreneurship	1.3	1	2	Lecture



Idea generation techniques	1.4	1	3	Lecture
Opportunity identification and market gap analysis	1.5	2	3	Lecture
Screening and selection of viable ideas	1.6	2	2	Lecture
Module 2: Business Planning and Startup Essentials				
Components of a business plan	2.1	3	2	Lecture
Basics of product/service development	2.2	3	3	Lecture
Market research and customer profiling	2.3	3	2	Lecture
Introduction to costing, pricing, and revenue models	2.4	4	3	Lecture
Marketing and branding strategies for startups	2.5	4	2	Lecture
Legal structure and regulatory formalities (licenses, MSME, GST, etc.)	2.6	4	3	Lecture
Module 3: Communication, Support Systems, and Startup Readiness				
Team building and leadership in startups	3.1	5	2	Lecture
Communication and interpersonal skills for entrepreneurs	3.2	5	2	Group Discussion
Institutional support: Startup India, MSME, incubators, banks, and funding bodies	3.3	5	3	Lecture
Role of mentors and networking in entrepreneurship	3.4	5	2	Group Discussion
Case studies of successful and failed startups	3.5	5	3	Group Discussion
Mini startup project: team-based idea development and pitching	3.6	5	3	Activity
Module 4: Teacher Specific Content				
(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)				
This content will be evaluated internally				

References

1. Entrepreneurship Development" by S.S. Khanka
2. Entrepreneurship" by Robert D. Hisrich, Michael Peters, and Dean Shepherd
3. Business Model Generation" by Alexander Osterwalder & Yves Pigneur
4. Innovation and Entrepreneurship" by Peter F. Drucker
5. The Personal MBA – Josh Kaufman

Course designed by Anoop A



SBU25RE4VAC200: ENVIRONMENTAL STUDIES AND HUMAN RIGHTS

Type of Course	GEC/Foundation		
Course Level	200-299		
Credit	3		
Course Delivery Duration	Theory (Hrs)	Practical (Hrs)	Total (Hrs)
	45	0	45
Pre-requisite (if any)	None		

Course Outcomes

No.	Description	Cognitive Level
CO1	Acquire a comprehensive understanding of environmental concepts, including the components of the environment, sustainable development principles, waste management strategies, pollution prevention, and the impact of human activities on natural ecosystems	U
CO2	Develop proficiency in assessing and mitigating disaster risks through hazard mapping, vulnerability assessment, and the implementation of preventive measures, preparing them to effectively manage disasters and minimise their impact	U
CO3	Develop familiarity with national and international perspectives on human rights, including definitions, relevance in India, key provisions of the Universal Declaration of Human Rights, and core issues such as poverty, overpopulation, and discrimination	U
CO4	Cultivate awareness of pressing environmental challenges such as pollution, deforestation, climate change, and natural disasters, and explore potential solutions and policies aimed at promoting environmental sustainability and resilience	U
CO5	Equipped to promote human rights literacy and awareness through an understanding of the mechanisms for redressal against human rights violations, including the role of the judiciary, government systems, and statutory commissions such as the NHRC	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1					1		1		
CO2			1						1	
CO3	1			1		1				
CO4			1				1		1	
CO5	1	1				1		1		1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Viva	Quiz	Home assignments	Written test	Problem based assignments	
CO1	x	x		x		x
CO2	x	x		x	x	x
CO3	x	x	x	x	x	x
CO4	x	x	x	x	x	x
CO5	x	x		x		x



Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Environmental Science (15 Hrs)				
Meaning and importance of environment, Biotic and abiotic components	1.1	1	2	Lecture
Environment and development, Concept of sustainable development	1.2	1	2	Lecture
Solid waste management-causes, effects and control measures of urban and industrial waste, Biodegradable and non-degradable, 3R's in waste management	1.3	1	3	Lecture
Pollution: Air, Water, Soil, Marine and Noise, Role of an individual in prevention of pollution	1.4	4	2	Lecture
Nuclear accidents and nuclear holocaust	1.5	1	1	Lecture
Sand mining, wetland reclamation, landscape changes, soil erosion, Deforestation and desertification, flood and drought	1.6	1	3	Lecture
Overexploitation Treats to fresh water resources of Kerala	1.7	4	1	Lecture
Tourism and its impact on environment	1.8	4	1	Lecture
Module 2: Disaster management (15 Hrs)				
Definition and meaning of key terms in Disaster Risk Reduction and Management	2.1	2	2	Lecture
Hazard types and hazard mapping; Vulnerability types and their assessment- physical, social, economic and environmental vulnerability	2.2	2	3	Lecture
Disaster risk assessment –approaches, procedures	2.3	2	2	Lecture
Measures for Disaster Risk Reduction – prevention, mitigation, and preparedness	2.4	2	3	Lecture
Relief; international relief organizations.	2.5	2	2	Lecture
Common disaster types in India	2.6	2	2	Lecture
National disaster management policy	2.7	2	1	Lecture
Module 3: Human Right education (15 Hrs)				
National and International Perspectives: Definitions of Human Right	3.1	3	2	Lecture
Relevance of Human Rights in India-Social Aspects-Economic Aspects-Political Aspects	3.2	3	3	Lecture
UDHR-Civil and political rights-Economic, social and cultural rights, Rights against torture, Discrimination and forced labour-Rights of the child	3.3	3	2	Lecture
Preamble to the Indian Constitution-Human Rights and Duties in Indian constitution	3.4	3	2	Lecture
Deprivation of Human Rights-The core issues: Poverty-Overpopulation-Illiteracy, Unsustainable Development, Disadvantageous Groups (Women, Children, SC/ST, Homeless and slum dwellers, physically and mentally handicapped, refugees and internally displaced persons)	3.5	3	2	Lecture
Redressal Mechanisms against Human Rights Violation: Judiciary -Government systems for Redressal - NHRC and	3.6	3,5	2	Lecture



other Statutory Commissions				
Creation of Human Rights Literacy and Awareness	3.7	3,5	2	Lecture
Module 4: Teacher Specific Content <i>(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)</i> This content will be evaluated internally				

Textbooks

1. Mckinney, M.L. and School, R.M. 1996. Environmental Science systems & Solutions, Web enhanced edition. 639p
2. R. Subramanian, Disaster Management, Vikas Publishing House, 2018
3. UNDP, Disaster Risk Management Training Manual, 2016

Reference

- 1) Miller, G. Tyler, and Scott E. Spoolman. Environmental Science. 15th Edition. Cengage Learning, 2021.
- 2) Kapoor, A.C., Disaster Management. 5th Edition. New Delhi: Sultan Chand & Sons, 2019.
- 3) Sen, Shibashis. Human Rights Education. 2nd Edition. PHI Learning Pvt. Ltd., 2020.
- 4) Cunningham, William P., and Mary Ann Cunningham. Environmental Science: A Global Concern. 14th Edition. McGraw-Hill Education, 2022.
- 5) Gupta, Kailash C. Disaster Management. 7th Edition. Atlantic Publishers & Distributors Pvt Ltd, 2021.

Course designed by Ms. Aswani B



SBU25RE4INT: INTERNSHIP

Type of Course	SDC/Major		
Course Level			
Credit	2		
Course Delivery Duration	Theory (Hrs)	Practicum (Hrs)	Total (Hrs)
			20 days on Sem Break
Pre-requisite (if any)	Internship should be done in a relevant field		

Course Outcomes

No.	Description	Cognitive Level
CO1	Demonstrate practical understanding of operational aspects in their domain by engaging in real-world industry settings.	U
CO2	Apply academic knowledge and skills to identify and solve industry-relevant problems.	A
CO3	Exhibit professional competencies including effective communication, teamwork, time management, and ethical responsibility.	A
CO4	Develop an understanding of workplace practices, expectations, and challenges.	U
CO5	Reflect critically on their internship experience to identify personal strengths, growth areas, and career aspirations.	E

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyze; E – Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1		1		3	1	2	1	1	
CO2	2	1	2		3	3		2	1	1
CO3	1		1	1	3			3		
CO4			2		3	1	1	2	2	1
CO5	1		1		3	2		1	1	

Course designed by Anoop A



SEMESTER V

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
SBU25RE5SDC300	SDC/Major	Fuel Cells and Hydrogen Energy	4	60	4
SBU25RE5SDC301	SDC/Major	Novel Energy Sources	5	75	4
SBU25RE5SDC302	SDC/Major	Geothermal Energy Systems	5	75	4
SBU25RE5SDC303	SDC/Major	Grid Integration and Smart Grid Technologies	5	75	4
SBU25RE5SEC300	SDC/Major	Softwares for Renewable Energy System Design	4	60	4
SBU25RE5VAC300	GEC/ Foundation	Environment, Health and Safety in Industries	3	45	3



SBU25RE5SDC300: FUEL CELLS AND HYDROGEN ENERGY

Type of Course	Major		
Course Level	300-399		
Credit	4		
Course Delivery Duration	Theory (Hrs)	Practical (Hrs)	Total (Hrs)
	60	0	60
Pre-requisite (if any)	Basic Physics		

Course Outcomes

No.	Description	Cognitive Level
CO1	Understand the working principles and role of hydrogen and fuel cells in renewable energy systems.	U
CO2	Understand various hydrogen production and storage methods suitable for practical deployment.	U
CO3	Understand a basic fuel cell setup and interpret its performance metrics.	U
CO4	Analyse different types of fuel cells and their applications in transportation, stationary, and portable power.	An
CO5	Evaluate the prospects and challenges of hydrogen energy adoption in the Indian context.	E

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	1	1	1		1		1	1	
CO2	2	1	1	1		1		1	1	
CO3	2	1	1	1		1		1	1	
CO4	2	1	1	1		1		1	1	
CO5	2	1	1	1		1		1	1	

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Viva voce	Home Assignments	Oral Presentation	Problem based assignments	Written test	
CO1	x	x	x	x	x	x
CO2	x	x	x	x	x	x
CO3	x	x	x	x	x	x
CO4	x	x	x	x	x	x
CO5	x	x			x	x

Course Content & Transaction Mechanism (Theory)

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Fundamentals of Hydrogen and Fuel Cells				
Energy needs and role of alternative fuels	1.1	5	2	Lecture and problem solving
Hydrogen as an energy carrier: properties and characteristics	1.2	1	5	Lecture and problem solving



Concept of fuel cells: history, basic working principle	1.3	1	3	Lecture and problem solving
Fuel cell efficiency and comparison with conventional energy systems	1.4	1	3	Lecture and problem solving
Relevance to clean energy and sustainable development	1.5	5	2	Lecture and problem solving
Module 2: Hydrogen Production and Storage Techniques				
Hydrogen production methods: Electrolysis (alkaline, PEM-based)	2.1	2	2	Lecture
Hydrogen production methods: Steam methane reforming (overview)	2.2	2	2	Lecture and problem solving
Hydrogen production methods: Biomass and biological methods (introductory)	2.3	2	2	Lecture and problem solving
Hydrogen production methods	2.4	2	1	Lecture and problem solving
Photo-electrochemical and solar thermochemical techniques (basic overview)	2.5	2	1	Lecture and problem solving
Hydrogen storage-Compressed gas and liquid hydrogen	2.6	2	2	Lecture and problem solving
Hydrogen storage-Metal hydrides and chemical storage	2.7	2	2	Lecture and problem solving
Safety aspects and hydrogen handling protocols	2.8	2	1	Lecture and problem solving
Module – 3: Types and Components of Fuel Cells				
Classification of fuel cells	3.1	3	1	Lecture
Proton Exchange Membrane Fuel Cell (PEMFC)	3.2	3	2	Lecture
Alkaline Fuel Cell (AFC)	3.3	3	2	Seminar/ Group discussion
Solid Oxide Fuel Cell (SOFC)	3.4	3	2	Lecture and problem solving
Molten Carbonate and Phosphoric Acid Fuel Cells (basic overview)	3.5	3	2	Lecture and problem solving
Main components: anode, cathode, electrolyte, catalyst	3.6	3	2	Lecture and problem solving
Fuel cell stack construction and operation	3.7	3	2	Lecture and problem solving
Performance parameters: voltage, current, power output, efficiency	3.8	3	2	Lecture and problem solving
Module 4: Applications and Integration				
Applications of fuel cells: Transportation (fuel cell vehicles)	4.1	4	2	Lecture
Applications of fuel cells: Stationary power (homes, industries)	4.2	4	1	Assignment
Applications of fuel cells: Portable and backup power	4.3	4	2	Lecture and problem solving
Hydrogen infrastructure: storage, transport, refueling stations	4.4	4	3	Lecture and problem solving
Fuel cell integration with renewable energy sources (solar, wind)	4.5	4	2	Lecture and problem solving
National and global hydrogen initiatives (e.g., India's	4.6	4	3	Lecture and



National Green Hydrogen Mission)				problem solving
Module 5: Teacher Specific Content (This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned) This content will be evaluated internally				

Reference

1. Srinivasan, S. *Fuel Cells: From Fundamentals to Applications*. Springer, 2006.
2. Kordesch, K., & Simader, G. *Fuel Cells and Their Applications*. Wiley-VCH, 1996.
3. Barbir, F. *PEM Fuel Cells: Theory and Practice*. Elsevier, 2013.
4. Ghosh, P.C. & Ghosh, S. *Hydrogen Energy: Fundamentals, Technology and Applications*. CRC Press, 2021.
5. MNRE & NITI Aayog Reports on Hydrogen Energy and the National Green Hydrogen Mission (India) – <https://mnre.gov.in>
6. O'Hayre, R. et al. *Fuel Cell Fundamentals*. Wiley, 4th Edition, 2016.

Course Designed by: Dr Subin P John



SBU25RE5SDC301: NOVEL ENERGY SOURCES

Type of Course	SDCE/Major		
Course Level	300-399		
Credit	4		
Course Delivery Duration	Theory (Hrs)	Practical (Hrs)	Total (Hrs)
	45	30	75
Pre-requisite (if any)	Nil		

Course Outcomes

No.	Description	Cognitive Level
CO1	Understand the basics of hydrogen energy and its applications.	U
CO2	Understand the principle and types of fuel cells	U
CO3	Develop an understanding of Electrochemical Energy Storage System	U
CO4	Understand ocean energy resources, Ocean Thermal Conversion Systems, Wave Energy Conversion Systems, and tidal power plant and conversion systems.	U
CO5	Apply practical skills to research hydrogen projects, prepare case studies on novel renewable energy technology, assess the feasibility.	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	1	1	1			2	1			
CO2	1	1		1		1	1			
CO3	1	1				2	1			
CO4	1	1				1	2			
CO5	1	1	1			1			3	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Viva	Assignments	Seminar/Group Discussion	Problem based assignments	Written test	
CO1	x				x	x
CO2	x				x	x
CO3	x		x		x	X
CO4	x	x		x	x	X
CO5					x	x

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Performance	Skill	Viva	Record	Model exam	
CO1						
CO2						
CO3						
CO4						
CO5	x	x	x	x	x	x



Course Content & Transaction Mechanism Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Hydrogen energy, Fuel Cell & Batteries (15 hrs)				
Basics of Hydrogen Energy - Production methods	1.1	1	1	Lecture/Group discussion
Storage and transportation - Application	1.2	1	1	Lecture/Group discussion
Fuel Cell: Principle of working -Basic thermodynamic and electrochemical principles -	1.3	1	2	Lecture/Group discussion
Classifications-Applications for power generations	1.4	1	1	Lecture/Group discussion
Electrochemical Energy Storage System: Batteries - Types - Working principles	1.5	1	1	Lecture/Group discussion
Role of carbon nanotubes in electrode	1.6	1	1	Lecture/Group discussion
Module 2: Ocean Energy (15 hrs)				
Ocean energy- Lambert's law, resources - Ocean energy routes - Ocean	2.1	2	2	Lecture
thermal energy conversion-types (open, closed, hybrid(basics), thermoelectric(basics))	2.2	2	2	Lecture
Advantages and disadvantages	2.3	2	3	Lecture/Problem solving
Wave energy – advantages and disadvantages, energy and power, conversion machines	2.4	2	1	Lecture/Problem solving
Tidal energy power plants-types, components, &power generation, Tidal energy conversion	2.5	2	2	Lecture
Small Hydropower Potential-advantages and disadvantages, classifications (elementary only)	2.6	2	2	Lecture
Module 3: (15 hrs)				
Magneto hydrodynamic (MHD) energy conversion: Principle of operation - Classifications	3.1	3	3	Lecture
Features of MHD Systems	3.2	3	3	Lecture
Magnetic and Electric Storage System: Super conducting magnetic energy storage (SMES) systems	3.4	3	2	Lecture
Capacitor and super capacitor-applications	3.5	3	2	Lecture
Module 4: Teacher Specific Content <i>(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)</i> This content will be evaluated internally				

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 5				
Research and summarize one major hydrogen project	1	5	6	Activity



Prepare a case study on a country leading in fuel cell technology	2	5	6	Activity
Evaluate the feasibility of implementing a green hydrogen hub	3	5	6	Assignment
Design and Build a Simple Wave Energy Converter Model	4	5	6	Group project
Explain types of ocean energy systems using diagrams or models.	5	5	6	Activity

Textbooks

1. Non-conventional energy sources; G. D. Rai; 2011, Fifth Edition, Khanna Publishers
2. Non-conventional Energy Sources and Utilization (Energy Engineering); R.K. Rajput; 2012, First Edition, S. Chand & Company Ltd.

Course Designed by Anju A



SBU25RE5SDC302: GEOTHERMAL ENERGY SYSTEMS

Type of Course	SDCE/Major		
Course Level	300-399		
Credit	4		
Course Delivery Duration	Theory (Hrs)	Practical (Hrs)	Total (Hrs)
	45	30	75
Pre-requisite (if any)	nil		

Course Outcomes

No.	Description	Cognitive Level
CO1	Understand Earth's heat flow and geothermal basics.	U
CO2	Understand different geothermal resources and systems.	U
CO3	Understand characteristics of geothermal resources.	U
CO4	Understand geothermal energy uses and environmental issues	U
CO5	Apply practical skills to study geothermal energy.	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	1	1				1	1			
CO2	2	1				1	1			
CO3	1					2				
CO4	1	2				1	1			
CO5	1			1				1	3	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Viva	Assignments	Seminar/Group Discussion	Problem based assignments	Written test	
CO1	x	x			x	x
CO2	x	x			x	x
CO3	x			x	x	x
CO4	x		x		x	x
CO5	x				x	x

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Performance	Skill	Viva	Record	Model exam	
CO1						
CO2						
CO3						
CO4						
CO5	x	x	x	x	x	x



Course Content & Transaction Mechanism Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Geothermal Basics (15 hrs)				
Thermal Structure of the Earth - Heat flow and temperature distribution - Heat generation and storage	1.1	1	2	Lecture
Heat Transfer Mechanisms - Heat conduction - Radiation - Convection	1.2	1	2	Lecture
Energy of Earth-Heat Flux	1.3	1	3	Lecture
Geothermal energy-Introduction	1.4	1	2	Lecture
Important aspect of geothermal energy	1.5	1	2	Lecture
Hot spring structure	1.6	1	2	Lecture
Earthquakes and volcanoes, Geothermal gradients	1.7	1	2	Lecture
Module – 2 Geothermal Resources and Systems (15 hrs)				
Geothermal resources	2.1	2	2	Lecture
Hydrothermal resources	2.2	2	1	Lecture
Vapour dominated/dry steam field and environmental aspect	2.3	3	3	Lecture
Hot water closed binary system	2.4	2	2	Lecture
Liquid dominated total flow concept system	2.5	2	2	Lecture
Geopressured resources	2.6	2	2	Lecture
HDR resources, molten rock chamber system, Hybrid geothermal fossil system	2.7	3	3	Lecture
Module 3: Environmental Aspects (15 hrs)				
Geothermal energy in India and Abroad	3.1	4	3	Seminar/ Group Discussion
Applications of geothermal energy	3.2	4	3	Seminar/ Group Discussion
Environmental problems	3.3	4	3	Seminar/ Group Discussion
Advantages and disadvantages of geothermal energy over other energy forms	3.4	4	3	Seminar/ Group Discussion
Future of Geothermal Energy, Cost and Economic Aspects	3.5	4	3	Seminar/ Group Discussion
Module 4: Teacher Specific Content (This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned) This content will be evaluated internally				



Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module- 5(30 hrs)				
Use Google Earth to locate and mark geothermal sites (e.g., hot springs, geothermal power plants) in India or worldwide.	5.1	5	6	Activity
Research 2 hot springs in India (e.g., Manikaran, Tattapani) and identify: Temperature range, Minerals found, Cultural or tourism value	5.2	5	6	Activity
Observe and understand heat conduction through a material by measuring temperature changes over time.	5.3	5	6	Lab/Practical
Prepare a comparative study of geothermal energy with two other renewable energy sources	5.4	5	6	Assignment
Discuss the environmental challenges associated with geothermal energy extraction.	5.5	5	6	Group Discussion/ Classroom activity

Textbooks

1. Non-Conventional Energy sources and Utilisation, S. Chand
2. Harsh K. Gupta, Sukanta Roy. Elsevier. "Geothermal Energy: An Alternative Resource for the 21st Century, first edition, 2006

Reference

1. GD. Rai "Non Conventional Energy Sources Khanna Publishers, New Delhi, 1st edition, 2010.
2. Ronald Dipippo: Elsevier Geothermal Power Plants Principles, Applications and Case Studies, 2nd edition 2007 Hamdy Makhlouf, 2015, Springer, Switzerland

Course designed by Anju A



SBU25RE5SDC303: GRID INTEGRATION AND SMART GRID TECHNOLOGIES

Type of Course	SDC/Major		
Course Level	300-399		
Credit	4		
Course Delivery Duration	Theory (Hrs) 45	Practical (Hrs) 30	Total (Hrs) 75
Pre-requisite (if any)	Basic knowledge about grid, renewable energy and electrical connections		

Course Outcomes

No.	Description	Cognitive Level
CO1	Describe the structure of power systems and challenges in integrating renewable energy sources with the grid.	U
CO2	Analyse power quality, stability, and synchronization for grid-connected renewable systems	An
CO3	Describe smart grid architecture, components, and communication technologies.	U
CO4	Evaluate demand-side management and real-time control strategies in smart grids.	E
CO5	Demonstrate renewable energy integration or smart grid concepts through practical activities or simulations.	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyze; E – Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	3	2	2		3	2	1		1
CO2	1	3	2			2				
CO3	1	1	1				2	2		2
CO4		2	2	1		1		3	1	2
CO5	2	1	1	1	2	1		2	1	3

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Viva	Assignments	Seminar/Group Discussion	Problem based assignments	Written test	
CO1	x	x			x	x
CO2	x	x			x	x
CO3	x		x		x	x
CO4	x			x	x	x
CO5	x				x	x



Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Performance	Skill	Viva	Record	Model exam	
CO1			x			x
CO2			x			x
CO3			x			x
CO4			x			x
CO5	x	x	x	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Grid Integration of Renewable Energy				
Power system overview and Grid	1.1	CO1	2	Lecture
Variability and intermittency	1.2	CO1	2	Lecture
Power quality parameters: voltagesag, harmonics, flicker	1.3	CO2	3	Lecture
Impact of high RE penetration on load flow and fault level	1.4	CO2	2	Lecture
Islanding detection methods and anti-islanding protection	1.5	CO2	2	Lecture
Use of FACTS and STATCOM in RE systems	1.6	CO2	2	Lecture
Overview of SCADA systems for monitoring	1.7	CO2	2	Lecture
Module – 2: Smart Grid Applications and Operations				
Definition and evolution of the Smart Grid	2.1	CO3	2	Seminar/ Group Discussion
Comparison: Traditional Grid vs. Smart Grid	2.2	CO3	2	Seminar/ Group Discussion
Key drivers and benefits of Smart Grids (efficiency, reliability, sustainability)	2.3	CO3	2	Seminar/ Group Discussion
Smart Grid architecture and components (AMI, PMU, SCADA, etc.)	2.4	CO3	3	Seminar/ Group Discussion
Overview of enabling technologies (ICT, IoT, AI/ML in smart grids)	2.5	CO3	2	Seminar/ Group Discussion
Smart metering and two-way communication	2.6	CO3	2	Seminar/ Group Discussion
Introduction to grid modernization challenges	2.7	CO3	2	Seminar/ Group Discussion
Module 3: Advanced Smart Grid Operations and Energy Management				
Demand Side Management (DSM) and Demand Response (DR)	3.1	CO4	3	Lecture
Real-time monitoring and automated fault detection	3.2	CO4	3	Lecture
Electric vehicles and smart charging infrastructure	3.3	CO4	3	Lecture
Distributed Energy Resources (DERs) and Microgrids	3.4	CO4	3	Lecture
Case studies of smart grid implementation (India and global examples)	3.5	CO4	3	Lecture
Module 4: Teacher Specific Content				
(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)				
This content will be evaluated internally				



Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module- 5				
Case study analysis (e.g., India's Smart Grid projects or global pilots)	5.1	5	6	Case Study activity
Group project: Design a basic smart grid layout for a campus or microgrid	5.2	5	6	Group project
Renewable Energy Integration Policy Debate	5.3	5	6	Group Discussion/ Classroom activity
Grid-Connected PV System Simulation	5.4	5	6	Software Simulation
Business Model Canvas: Smart Grid Startup	5.5	5	6	Group project

Reference

1. Renewable and Efficient Electric Power Systems, Gilbert M. Masters
2. Grid Integration of Wind Energy Conversion Systems, Siegfried Heier
3. Integration of Renewable Energy Sources with Smart grid, Wiley
4. Smart Grid: Technology and Applications, Janaka Ekanayake, Nick Jenkins, et al.

Course designed by Anoop A



SBU25RE5SEC300: SOFTWARES FOR RENEWABLE ENERGY SYSTEM DESIGN

Type of Course	Skill Enhancement Course		
Course Level	300-399		
Credit	3		
Course Delivery Duration	Theory (Hrs) 30	Practical (Hrs) 30	Total (Hrs) 60
Pre-requisite (if any)	Fundamental concepts of Solar Photovoltaics		

Course Outcomes

No.	Description	Cognitive Level
CO1	Understand the basic workflow and components involved in PV system design using PVsyst.	U
CO2	Design and configure a PV system simulation project based on site-specific parameters.	A
CO3	Analyse energy yield, losses, and performance reports generated from PVsyst.	An
CO4	Compare design alternatives to optimize system layout and component selection.	A
CO5	Present a complete solar PV project report with PVsyst simulation results.	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E – Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	3		1	1		1	1	1		2
CO2	1		2		1	1		2	1	2
CO3		1	1	1				1		2
CO4		1				1				2
CO5	1			3		1			1	2

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Viva	Assignments	Seminar/Group Discussion	Problem based assignments	Written test	
CO1	x	x			x	x
CO2	x		x		x	x
CO3	x				x	x
CO4	x			x	x	x
CO5	x			x	x	x

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Performance	Skill	Viva	Record	Model exam	
CO1	x	x	x	x	x	x
CO2	x	x	x	x	x	x
CO3		x	x	x	x	x
CO4		x	x	x	x	x
CO5		x	x	x	x	x



Course Content & Transaction Mechanism Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Introduction to Solar PV System Design				
Introduction to Solar PV Design Process- Manual vs software-based design	1.1	1	2	Lecture
Understanding PVsyst Interface & Workflow	1.2	1	3	Lecture
Creating a New Project in PVsyst	1.3	3	2	Online/Live demonstration
PV Module and Inverter Selection	1.4	3	2	Online/Live demonstration
Selecting components from database; editing and creating new module/inverter models	1.5	3	2	Online/Live demonstration
Array sizing, connection type, voltage matching, inverter efficiency, nominal power	1.6	3	3	Online/Live demonstration
Introduction to Loss Parameters and System Checks	1.7	3	2	Online/Live demonstration
Module 2: Shading Analysis and Running a Simulation				
Shading Analysis and Creating Shading Scene	2.1	2	4	Online/Live demonstration
Energy Yield Simulation and Output Analysis	2.2	3	2	Online/Live demonstration
Running a PVsyst Simulation	2.3	4	2	Online/Live demonstration
Understanding Simulation Outputs	2.4	4	2	Online/Live demonstration
Design Optimization Techniques	2.5	4	2	Online/Live demonstration
Analysis of a PVsyst Report	2.6	5	2	Online/Live demonstration
Module 3: Teacher Specific Content (This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned). This content will be evaluated internally				

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 4				
System Designing in PVsyst	1	1	6	Lab sessions
Shading Analysis	2	2	6	Lab sessions
Result Analysis and Optimization	3	5	6	Lab sessions
System Losses and Simulation	4	3	6	Lab sessions
Mini Project – Complete Design and Report	5	5	6	Lab sessions



Reference

1. PVsyst User Manual (PDF)
2. PVsyst Website – Tutorials Section

Course designed by Anoop A



SBU25RE5VAC300: ENVIRONMENT, HEALTH, AND SAFETY IN INDUSTRIES

Type of Course	Foundation		
Course Level	300-399		
Credit	3		
Course Delivery Duration	Theory (Hrs) 45	Practical (Hrs) 0	Total (Hrs) 45
Pre-requisite (if any)	Basic Physics and Chemistry		

Course Outcomes

No.	Description	Cognitive Level
CO1	Understand the environmental impacts and legal frameworks applicable to industrial operations.	U
CO2	Analyse workplace hazards and appropriate personal and engineering controls.	An
CO3	Apply the principles of occupational health and hygiene to assess risks in renewable energy settings.	A
CO4	Evaluate the effectiveness of environmental and safety management systems in industrial practices.	E
CO5	Apply basic EHS plan including hazard identification and control strategies for a renewable energy facility.	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	1	1	1		1		1	1	1
CO2	1	1	1	1		1		1	1	1
CO3	1	1	1	1		1		1	1	1
CO4	1	1	1	1		1		1	1	1
CO5	1	1	1	1		1		1	1	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Viva voce	Home Assignments	Oral Presentation	Literature Survey	Written test	
CO1	x		x	x	x	x
CO2	x	x	x	x	x	x
CO3	x	x	x	x	x	x
CO4	x	x	x	x	x	x
CO5	x				x	x

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Performance	Skill	Viva	Record	Model exam	
CO1			x	x	x	x
CO2	x			x	x	x
CO3				x	x	x
CO4		x		x	x	x
CO5				x	x	x



Course Content & Transaction Mechanism Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Environmental Management in Industries				
Introduction to environmental concerns in industries	1.1	1	1	Lecture
Pollution types: air, water, noise, and solid waste	1.2	2	4	Lecture
Environmental Impact Assessment (EIA)	1.3	1	2	Lecture
Waste minimization and cleaner production	1.4	1	3	Lecture
Environmental laws and regulations (India-specific: Water Act, Air Act, Environment Protection Act)	1.5	1	5	Seminar
Module 2 : Industrial Health and Occupational Safety				
Introduction to occupational health and safety (OHS)	2.1	3	2	Lecture
Common industrial hazards: physical, chemical, biological, ergonomic	2.2	2,3	4	Lecture
Personal Protective Equipment (PPE) and its selection	2.3	4	2	Lecture
Industrial hygiene and exposure control	2.4	4	2	Lecture
Case studies: solar PV module manufacturing, wind turbine maintenance, biomass processing units	2.5	5	5	Lecture
Module 3: Safety Management Systems and Standards				
Hazard identification and risk assessment (HIRA)	3.1	3,4	2	Lecture
Safety audits, incident/accident investigation	3.2	3,4	3	Lecture
Safety management systems (SMS) and documentation	3.3	3,4	2	Lecture
Fire safety, electrical safety, confined space safety	3.4	3,4	3	Assignment
ISO 14001 (Environmental Management), ISO 45001 (Occupational Health & Safety)	3.5	3,4	5	Lecture
Module 4: Teacher Specific Content <i>(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)</i>				
This content will be evaluated internally				

Reference

1. **K.K. Jain**, *Industrial Safety, Health and Environment Management Systems*, Khanna Publishers
2. **R.K. Jain & Sunil S. Rao**, *Industrial Safety, Health and Environment*, Khanna Publishers
3. **David L. Goetsch**, *Occupational Safety and Health for Technologists, Engineers, and Managers*, Pearson
4. **NIOSH & OSHA Publications**, U.S. Department of Labor
5. Indian Regulations:
6. The Factories Act, 1948
7. The Environment (Protection) Act, 1986
8. Hazardous Waste Management Rules
9. OHS guidelines from Ministry of Labour & Employment, Government of India

Online Resources:

1. ILO: www.ilo.org
2. DGMS: www.dgms.gov.in



3. NPTEL course: “Health, Safety and Environmental Management in Mining and Allied Industries”

Course Designed by: Dr Subin P John



SEMESTER VI

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
SBU25RE6SDC300	SDC/Major	Solar Thermal Technology	5	75	4
SBU25RE6SDC301	SDC/Major	Advanced Solar Photovoltaics	5	75	4
SBU25RE6SDC302	SDC/Major	Electric Vehicles and Batteries	5	75	4
SBU25RE6PRJ	SDC/Major	Project	8	120	4
SBU25RE6SEC300	SDC/Major	Energy storage systems	3	45	3
SBU25RE6VAC300	GEC/ Foundation	Carbon Audit and Management	3	45	3



SBU25RE6SDC300: SOLAR THERMAL TECHNOLOGY

Type of Course	SDCE		
Course Level	300-399		
Credit	4		
Course Delivery Duration	Theory (Hrs)	Practical (Hrs)	Total (Hrs)
	45	30	75
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Understand the sun, different types of solar radiation, and the measurement of that radiation.	U
CO2	Understand the concepts of flat plate collectors and how to derive their efficiency.	U
CO3	Analyse the technical and physical principles of different solar collectors.	An
CO4	Analyse various materials used for solar concentrators.	An
CO5	Understand and apply solar energy applications such as heating, cooling, desalination, drying, and cooking.	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	1	1	1		1	1		1	
CO2	1	2		1		1			1	
CO3	1	1	1	1		1		1	1	2
CO4	1	2		1		1	1		1	
CO5	1	1	1	2	1	1		1	1	2

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Viva	Assignments	Seminar/ Group Discussion	Problem based assignments	Written test	
CO1	x	x			x	x
CO2	x	x	x		x	x
CO3	x	x	x		x	x
CO4	x		x	x	x	x
CO5						

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Performance	Skill	Viva	Record	Model exam	
CO1						
CO2						
CO3						
CO4						
CO5	X	x	x	x	x	x



Course Content & Transaction Mechanism Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Solar Radiation				
The sun as the source of radiation - Solar Constant	1.1	1	2	Lecture
Spectral distribution of extraterrestrial radiation and its variation	1.2	1	3	Lecture
Basic Earth Sun angles	1.3	1	2	Lecture
Availability of solar radiation	1.4	1	3	Seminar/Group Discussion
Direct and Diffuse radiation	1.5	1	2	Lecture
Measurement of diffuse and direct radiation	1.6	1	3	Lecture
Module 2: Flat Plate Collectors				
Liquid Flat Plate Collector- Materials for flat plate collector	2.1	2	2	Seminar/Group Discussion
Efficiency of flat plate collectors Flat plate air heating collectors-Types and novel designs	2.2	2	3	Lecture
Parameters characterizing solar concentrators	2.3	2	2	Lecture
Classification of solar concentrators Thermodynamic limits to concentration - Solar concentrator mountings	2.4	2	3	Lecture
Performance analysis of cylindrical parabolic collector	2.5	4	3	Seminar/Group Discussion
Compound parabolic collector - Point focusing solar concentrators - Materials for solar concentrators	2.6	4	2	Seminar/Group Discussion
Module 3: Solar Thermal Applications				
Solar water heater-Natural and forced circulation type	3.1	3	2	Seminar/Group Discussion
Solar cookers -Types-Solar Still- Solar drying of food-Basics- Types	3.2	3	3	Seminar/Group Discussion
Solar heating of buildings- active and passive	3.3	3	3	Seminar/Group Discussion
Solar cooling of buildings-refrigeration and air conditioning	3.4	3	3	Lecture
Solar furnaces	3.5	3	2	Lecture
Solar thermal energy storage	3.6	3	2	Lecture
Module 4: Teacher Specific Content (This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned) This content will be evaluated internally				

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Evaluation of different parameters of Flat-Plate Collector in thermosyphonic mode of flow with different tilt angle	5.1	5	5	Demonstration and peer learning



Evaluation of different parameters of Flat-Plate Collector in forced mode of flow with fixed input parameters	5.2	5	5	Demonstration and peer learning
Evaluation of different parameters of Flat-Plate Collector in forced mode of flow for different flow rate	5.3	5	5	Demonstration and peer learning
Evaluation of different parameters of Flat- Plate Collector in forced mode of flow for different radiation level	5.4	5	5	Demonstration and peer learning
Evaluation of different parameters of Flat- Plate Collector in forced mode of flow with different inlet water temperature	5.5	5	5	Demonstration and peer learning
Evaluation of different parameters of Flat- Plate Collector in forced mode of flow for different tilt angle.	5.6	5	5	Demonstration and peer learning

Text Books

1. Solar Energy: Fundamentals and Applications; H. P. Garg & J. Prakash; 2000, Tata McGraw-Hill
2. Solar Thermal Energy Storage; H.P. Garg, S.C. Mullick and A. K. Bhargava; 1985, Springe

Course Designed by Aswani B/Anju A



SBU25RE6SDC301: ADVANCED SOLAR PHOTOVOLTAICS

Type of Course	SDCE/Major		
Course Level	300-399		
Credit	4		
Course Delivery Duration	Theory (Hrs)	Practical (Hrs)	Total (Hrs)
	45	30	75
Pre-requisite (if any)	NIL		

Course Outcomes

No.	Description	Cognitive Level
CO1	Understanding of various solar cell design constraints	U
CO2	Understand about different solar cell fabrication techniques	U
CO3	Understand about various thin film fabrication methods	U
CO4	Understanding about various PV system configurations like standalone, grid	U
CO5	Apply the theoretical knowledge to evaluate the performance analysis of IV characteristics of PV module.	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	1	1				1	1			
CO2	1	1				1				
CO3	1					1				
CO4	1	1				1	1			
CO5	1			1				2	3	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Viva	Assignments	Seminar/Group Discussion	Problem based assignments	Written test	
CO1	x				x	x
CO2	x				x	x
CO3	x		x		x	x
CO4	x	x		x	x	x
CO5					x	x

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Performance	Skill	Viva	Record	Model exam	
CO1						
CO2						
CO3						
CO4						
CO5	x	x	x	x	x	x



Course Content & Transaction Mechanism Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Design of Solar Cells (15 Hrs)				
Upper limits of cell parameters: Short circuit current-open circuit	1.1	1	2	Lecture
voltage, fill factor - Losses in Solar cells - Model of a solar cell- effect of series and shunt	1.2	1	2	Lecture
resistance, solar radiation and temperature on the efficiency of solar Cells -Solar cell design	1.3	1	2	Lecture
Upper limits of cell parameters: Short circuit current-open circuit	1.4	1	3	Lecture
voltage, fill factor - Losses in Solar cells - Model of a solar cell- effect of series and shunt	1.5	2	2	Lecture
solar radiation and temperature on the efficiency of solar Cells-Solar cell design	1.6	2	2	Lecture
Module 2: (15 Hrs)				
c-Si Solar Cells, GaAs Solar Cells, Poly crystalline Si Solar Cells, a-Si Solar Cells	2.1	2	1	Lecture
Thin Film Solar Cells: Various layers of Thin film solar cells: Absorber layer, Window layer	2.2	2	2	Lecture
(CdS), Transparent conducting oxides (FTO, ZnO)	2.3	3	2	Lecture
Examples for thin film solar cells: CdTe, CIGS, CZTS based solar cells.	2.4	3	3	Lecture
Other Solar Cell technologies: organic solar cells, Dye sensitized Solar cells, Quantum Dot	2.5	3	4	Lecture
sensitized Solar cells (qualitative)	2.6	3	3	Lecture
Module 3: Material Fabrication Technologies (15 Hrs)				
Silicon from quartz, MGS, EGS, Siemens reactor, Fluidised bed reactor, Gettering. Zone refining	3.1	4	5	Lecture
Growth of crystalline silicon, Bridgmann, Czochralski and floating zone methods.	3.2	4	4	Lecture
Wafer dicing, Kerf loss	3.3	4	2	Lecture
Epitaxial growth methods, MBE, MOCVD, LPE, VPE	3.4	4	2	Lecture
Thin film deposition methods, evaporation, sputtering, wet chemical, spray pyrolysis, screen	3.5	4	2	Lecture
Module 4: Teacher Specific Content				
<i>(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)</i>				
This content will be evaluated internally				



Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 5				
Series and Parallel connection of solar cells	1	2	6	Practical/lab
Study the variation of open-circuit voltage and short-circuit current of a solar cell with light intensity	2	4	6	Practical/lab
I-V characteristics of a PV Module-Calculation of series and shunt resistance	3	4	6	Practical/lab
I-V characteristics of a PV module with variation in intensity of radiation.	4	1	6	Practical/lab
P-V characteristics of a PV module with variation in intensity of radiation.	5	1	6	Practical/lab

Textbooks

1. Solar Photovoltaics: Fundamental, Technologies and Applications; C.S. Solanki, 2011, Prentice Hall of India.
2. Handbook of Photovoltaic Science and Engineering; Antonio Luque, Steven Hegedus, 2003, John Wiley and Sons

Course Designed by Anju A



SBU25RE6SDC302: ELECTRIC VEHICLES AND BATTERIES

Type of Course	Major		
Course Level	300-399		
Credit	4		
Course Delivery Duration	Theory (Hrs)	Practical (Hrs)	Total (Hrs)
	45	30	75
Pre-requisite (if any)	Basic Physics and Mathematics		

Course Outcomes

No.	Description	Cognitive Level
CO1	Understand the types, components, and working principles of electric vehicles.	U
CO2	Analyse the performance characteristics of electric motors and their control systems used in EVs.	An
CO3	Evaluate different battery technologies based on energy density, lifecycle, and application suitability.	E
CO4	Apply practical skills in testing, assembling, and simulating electric vehicle components.	A
CO5	Apply suitable EV and battery configurations for specific applications based on performance and sustainability criteria.	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	1	1	1		2		1		1
CO2	2	1	1	1		2		1		1
CO3	2	1	1	1		2		1		1
CO4	2	1	1	1		2		1		1
CO5	2	1	1	1		2		1		1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Viva voce	Home Assignments	Oral Presentation	Problem based assignments	Written test	
CO1	x		x	x	x	x
CO2	x	x	x	x	x	x
CO3	x	x	x	x	x	x
CO4	x	x	x	x	x	x
CO5	x				x	x

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Group tutorial work	Oral Presentation	Viva voce	Case study	Team project report	
CO1		x	x			x
CO2		x	x			x
CO3		x	x			x
CO4		x	x			x
CO5	x	x	x	x	x	x



Course Content & Transaction Mechanism Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Introduction to Electric Vehicles (EVs)				
Overview of mobility and environmental issues	1.1	1	1	Lecture
Types of electric vehicles: BEV, HEV, PHEV, FCEV	1.2	1	4	Lecture
Components of EV: motor, controller, charger, battery, regenerative braking	1.3	1	4	Lecture
vehicle dynamics: traction, acceleration, gradeability	1.4	1	3	Lecture
Comparison of EVs with conventional vehicles (efficiency, emissions)	1.5	1	3	Lecture
Module 2 : Electric Motors and Control Systems				
Types of motors used in EVs: BLDC, PMSM, Induction Motor	2.1	2	6	Lecture
Motor drive control techniques: vector control, direct torque control	2.2	2	4	Lecture
Power electronics for EVs: inverters, DC-DC converters	2.3	2	2	Lecture
Control strategies for speed and torque	2.4	2	1	Lecture
Regenerative braking systems and energy recovery	2.5	2	2	Lecture
Module 3: Battery Technology and Energy Storage				
Fundamentals of batteries: working principle, types, and characteristics	3.1	3	3	Lecture
Battery types: Lead-acid, Li-ion, NiMH – comparative analysis	3.2	3	3	Lecture
Battery management system (BMS): functions, protection, SoC and SoH estimation	3.3	3	3	Lecture
Charging infrastructure: AC/DC charging, fast charging, battery swapping	3.4	3	3	Assignment
Safety, standards, and disposal of batteries	3.5	3	3	Seminar
Module 4: Teacher Specific Content <i>(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)</i> This content will be evaluated internally				

Reference

1. Larminie, J., & Lowry, J. (2012). *Electric Vehicle Technology Explained* – Wiley
2. Husain, I. (2003). *Electric and Hybrid Vehicles: Design Fundamentals* – CRC Press
3. Andrea, D. (2010). *Battery Management Systems for Large Lithium Ion Battery Packs* – Artech House
4. Rao, S. (2021). *Electric Vehicles and Renewable Energy* – Khanna Publishers

Online Courses / Resources

1. NPTEL: *Electric Vehicles* (IIT Madras), *Energy Storage* (IIT Delhi)
2. FAME India Scheme – <https://fame2.heavyindustry.gov.in/>
3. Ministry of Power & MNRE websites for policy updates
4. Bharat EV specs – ARAI guidelines



Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 5				
Identification and function of EV components (motor, controller, inverter)	1	4,5	6	Industry visit
Hands-on assembly of a simple EV model or e-bike demo kit	2	4,5	6	Small project
Testing motor performance using drive system	3	4,5	6	Industry visit
Battery testing: capacity, SoC, internal resistance	4	4,5	6	Practical
Simulation of EV drive cycles and battery discharge patterns using software (e.g., MATLAB/Simulink or Scilab)	5	4,5	6	Practical

Course Designed by: Dr Subin P John



SBU25RE6SEC300: ENERGY STORAGE SYSTEMS

Type of Course	Major		
Course Level	300-399		
Credit	3		
Course Delivery Duration	Theory (Hrs)	Practical (Hrs)	Total (Hrs)
	45	0	45
Pre-requisite (if any)	Basic Physics and Chemistry		

Course Outcomes

No.	Description	Cognitive Level
CO1	Understand the need, functions, and classifications of energy storage systems in renewable energy contexts.	U
CO2	Analyse various battery technologies based on their performance characteristics and applications.	An
CO3	Apply basic battery storage system for a small-scale solar PV installation.	A
CO4	Evaluate suitable energy storage technologies for different renewable energy systems (e.g., wind, solar, hybrid).	E
CO5	Evaluate integration challenges and strategies of energy storage systems with the electric grid.	E

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	1	1	1		1		1		
CO2	1	1	1	1		1		1		
CO3	1	1	1	1		1		1		
CO4	1	1	1	1		1		1		
CO5	1	1	1	1		1		1		

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Viva voce	Home Assignments	Oral Presentation n	Problem based assignments	Written test	
CO1	x		x	x	x	x
CO2	x	x	x	x	x	x
CO3	x	x	x	x	x	x
CO4	x	x	x	x	x	x
CO5	x		x		x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Fundamentals of Energy Storage				
Need for energy storage in renewable systems	1.1	1	1	Lecture
Storage parameters: energy density, power density, efficiency, response time, self-discharge	1.2	1	5	Lecture



Classification: Mechanical, Electrical, Electrochemical, Chemical, Thermal	1.3	1	6	Lecture
Applications in grid and off-grid systems	1.4	1,5	3	Lecture
Module 2: Electrochemical and Electrical Energy Storage				
Batteries: Lead-acid, Lithium-ion, Flow batteries – construction, working, characteristics	2.1	2,3	6	Lecture
Battery management systems (BMS)	2.2	2,3	2	Lecture
Fuel Cells: Types, principles, applications	2.3	4	2	Seminar
Supercapacitors and ultracapacitors: comparison with batteries	2.4	4	2	Lecture
Charging-discharging cycles, DoD, SoC, life cycle	2.5	4	3	Lecture
Module 3: Mechanical and Thermal Energy Storage				
Mechanical storage: Pumped hydro, compressed air, flywheel energy storage	3.1	4	5	Lecture
Thermal storage: Sensible and latent heat storage, phase change materials (PCMs)	3.2	4	4	Lecture
Applications in solar thermal and combined heat- power (CHP) systems	3.3	4	3	Lecture
Storage system selection and design considerations for RE integration	3.4	5	3	Assignment
Module 4: Teacher Specific Content				
<i>(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)</i>				
This content will be evaluated internally				

Textbooks

1. Huggins, R.A., *Energy Storage: Fundamentals, Materials and Applications*, Springer, 2016.
2. Dunn, B. et al., “Electrochemical Energy Storage for Renewable Sources and Grid Balancing,”
3. *Chemical Reviews*, 2011.
4. Chen, H. et al., “Progress in Electrical Energy Storage System,” *Renewable and Sustainable Energy Reviews*, 2009.

Web Resources:

1. NPTEL Course: “Energy Storage Devices and Technology” by Prof. B. Ghosh, IIT Roorkee
2. MNRE Reports on Energy Storage Integration in India
3. IRENA: www.irena.org – Reports and white papers on global energy storage trends

Course Designed by: Dr Subin P John



SBU25RE6VAC300: CARBON AUDIT AND MANAGEMENT

Type of Course	VAC		
Course Level	300-399		
Credit	3		
Course Delivery Duration	Theory (Hrs)	Practical (Hrs)	Total (Hrs)
	45	0	45
Pre-requisite (if any)	Fundamentals of climate change, energy, environment and sustainability issues		

Course Outcomes

No.	Description	Cognitive Level
CO1	Explain the concepts of carbon footprint, carbon audit, and carbon neutrality	U
CO2	Conduct basic carbon auditing for households, institutions, or small industries	A
CO3	Identify and evaluate carbon emission sources and reduction opportunities	An
CO4	Recommend renewable energy and energy efficiency interventions for emission reduction	A
CO5	Understand national and international carbon accounting frameworks	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E –Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	3	1	1		1	2	1	1	1
CO2		2	2	1		1		2		2
CO3	1	1	3	1		1	1		1	3
CO4	3	1	2	1	1	2	2	2	1	3
CO5		2				2	2			

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Viva	Assignments	Seminar/ Group Discussion	Problem based assignments	Written test	
CO1	x				x	x
CO2	x			x	x	x
CO3	x		x		x	x
CO4	x	x			x	x
CO5	x	x			x	x

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Performance	Skill	Viva	Record	Model exam	
CO1		x	x	x	x	x
CO2		x	x	x	x	x
CO3		x	x	x	x	x
CO4	x	x	x	x	x	x
CO5	x	x	x	x	x	x



Course Content & Transaction Mechanism Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Introduction to Carbon Audit and Emission Sources				
Basics of climate change and the role of CO ₂	1.1	1	3	Lecture
Carbon footprint: Definition and types (Scope 1, 2, and 3 emissions)	1.2	1	3	Lecture
Importance of carbon audits in sustainability and compliance	1.3	2	3	Lecture
Tools and methods for carbon auditing (manual and software-based)	1.4	2	2	Lecture
Sector-wise emission sources: residential, industrial, transport, agriculture	1.5	3	2	Lecture
Overview of carbon accounting protocols: GHG Protocol, ISO 14064, IPCC Guidelines	1.6	1	2	Lecture
Module 2: Carbon Accounting and Reporting Standards				
GHG Protocol (Corporate Standard, Product Standard)	2.2	5	3	Lecture
ISO 14064, IPCC Guidelines for National Inventories	2.3	5	3	Lecture
Carbon reporting tools and platforms (e.g., CDP, GRI, VER)	2.4	2	3	Lecture
Life Cycle Emissions and carbon intensity	2.5	4	3	Lecture
Data collection, emission factors, and calculating CO ₂ e	2.6	4	3	Lecture
Module – 3 : Carbon Management and Net-Zero Strategies				
Introduction to net-zero, climate positive, and carbon neutrality	3.1	3	3	Seminar/Group discussion
Carbon mitigation hierarchy: Avoid, Reduce, Replace, Offset	3.2	3	3	Seminar/Group discussion
Renewable energy as a mitigation tool: Solar, Wind, Bioenergy	3.3	3	2	Seminar/Group discussion
Energy efficiency interventions in buildings, transport, industry	3.4	3	2	Seminar/Group discussion
Carbon Offsets and Market Mechanisms	3.5	5	2	Lecture
Green credits, ESG, and corporate carbon strategies	3.6	5	3	Lecture
Module 4: Teacher Specific Content (This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned). This content will be evaluated internally				

Reference and Textbooks

1. Carbon Management in the Built Environment – Rohinton Emmanuel Carbon Accounting and Reporting – Arnaud Brohé
2. IPCC Reports on Climate Mitigation

Course designed by Anoop A



SBU25RE6PRJ: PROJECT

Type of Course	SDC/Major		
Credit	4		
Course Delivery	Theory (Hrs)	Practical (Hrs)	Total (Hrs)
Duration	0	120	120
Pre-requisite (if any)	None		

Course Outcomes

No.	Description	Cognitive Level
CO1	Formulate a project objective and design a structured plan for solving a real-world or research-based problem.	E
CO2	Apply relevant tools, techniques, and theoretical knowledge to implement the project effectively.	A
CO3	Analyze project outcomes and evaluate results with respect to the initial objectives and constraints.	An
CO4	Demonstrate project management and documentation skills, including data recording, time management, and reporting.	U
CO5	Present project findings effectively through oral presentation and technical writing, using appropriate formats and communication tools.	E

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1		1	2	3	1	2	1	1	3
CO2	2	1	2	2	3	3		2	1	1
CO3	1		1	1	3			3		
CO4			2		3	1	1	2	2	1
CO5	1		1	2	3	2		1	1	3

Course designed by Anoop A



Rubrics for Assignment Valuation

Criteria	Level 1	Level 2	Level 3	Level 4	Score
Content Accuracy	The contents are incorrect.	The contents are correct but do not match the topic assigned	The contents are accurate and are related to the topics assigned.	The contents are accurate and exactly matches the topic assigned.	1
Presentation	Presentation of the subject/matter is weak.	Presentation of the matter is good.	Presentation is done using data	Presentation is done using data, tables and/or other relevant tools.	1
Inference	The topics are very poorly concluded.	A conclusion is made but an inference is missing.	A conclusion is made with an inference.	Properly and logically concluded using an inference.	1
Quality of Submission	Very poor Quality of submission	The assignment is not neatly written and submitted.	The assignment is written and submitted with neatness	The assignment is written and submitted with overall neatness and proper format	1

Rubrics for Seminar/ Group Discussion presentation

Criteria	Level 1	Level 2	Level 3	Level 4	Score
Understanding of the topic	Least/Basic understanding of the topics	A fair understanding of the topic	A sound understanding of the main topics and related other topics.	A remarkably sound understanding of the topic with in-depth knowledge	1
Presentation Skills	Lacking the presentation skills	Able to Present the seminar fairly	Able to present the seminar with confidence	Able to present the seminar with confidence and effective communication skills.	1
Ease of explanation	Unable to explain topics	Able to explain with ease	Able to explain the topics easily and effectively	Able to explain the topics effectively with proper communication and interaction.	1
Use of Modern tools	No tools used	Use of PowerPoint presentation	Use of tutorials and demonstrations	Use of PowerPoint presentation, tutorials and demonstrations	1



Rubrics for Viva

Criteria	Level 1	Level 2	Level 3	Level 4	Score
Subject Knowledge	Shows poor understanding of the subject	Shows limited understanding, with some incorrect answers	Demonstrates good understanding with mostly correct answers	Demonstrates deep understanding and confidently answers all questions	1
Clarity of Communication	Lacks clarity, uses vague or incorrect terms	Communicates ideas with some clarity, but lacks fluency	Communicates clearly and uses relevant terminology	Communicates fluently and effectively with technical precision	1
Logical Thinking & Justification	Answers lack logic or structure	Attempts to justify answers but lacks depth	Provides logical answers with reasonable justification	Provides insightful answers with strong reasoning and analysis	1
Response to Follow-up Questions	Unable to respond or guesses answers	Responds partially or with prompting	Handles most follow-ups with ease	Responds thoughtfully and extends discussion when appropriate	1

Rubrics for Problem Based Assignment

Criteria	Level 1	Level 2	Level 3	Level 4	Score
Understanding of the Problem	Misinterprets or lacks clarity about the problem	Understands partially but misses key aspects	Understands the problem clearly with minor gaps	Fully understands and interprets the problem accurately	1
Approach and Strategy	Lacks structure or logic in approach	Attempts a basic method with limited justification	Uses a clear and logical method to solve the problem	Applies an innovative, well-structured, and efficient method	1
Quality of Solution	Incomplete or mostly incorrect solution	Partially correct with noticeable errors	Mostly accurate with minor issues	Accurate, complete, and well-reasoned solution	1
Presentation and Clarity	Poorly organized, unclear, or hard to follow	Basic structure, limited clarity	Well-structured with clear explanation	Highly organized, neat, and clearly articulated	1

Rubrics for Performance

Criteria	Level 1	Level 2	Level 3	Level 4	Score
Task Understanding	Does not understand task; needs full guidance	Understands task partially; frequent help needed	Understands task well; occasional guidance needed	Fully understands and performs task independently	1



Execution of Task	Cannot complete task; lacks understanding	Completes with help; many errors	Completes correctly with minor errors	Completes accurately, efficiently, and independently	1
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Rubrics for Skill

Criteria	Level 1 – Beginner	Level 2 – Basic	Level 3 – Proficient	Level 4 – Advanced	Score
Tool Handling & Technique	Unable to handle tools or uses them incorrectly	Uses basic tools with frequent help	Uses tools correctly with minimal support	Uses tools confidently, efficiently, and safely	1
Accuracy in Task Execution	Task incomplete or mostly incorrect	Completes task with several errors	Completes task with acceptable accuracy	Completes task with precision and high-quality output	1

Rubrics for Record

Criteria	Level 1 – Beginner	Level 2 – Basic	Level 3 – Proficient	Level 4 – Advanced	Score
Content Completeness	Incomplete; missing multiple entries or sections	Basic entries made; some gaps present	Mostly complete with essential sections included	Fully complete with all required content and structure	1
Clarity & Presentation	Unclear, disorganized, or untidy	Legible but lacks proper structure	Neatly written with acceptable format	Well organized, clear, and professionally presented	1