

Course Title : RENEWABLE & NON-CONVENTIONAL ENERGY
 Course Code : PE-EE-501C
 L-T-P-S Structure : 3-0-0-0
 Credits : 3
 Pre-requisite : 1. Basic Electrical Engineering (ES-EE-101)
 2. Electric Circuit Theory (PC-EE-301)
 4. Electric Machine-I (PC-EE-401)
 Course Coordinator : J. B. Basu
 Team of Instructors : J. B. Basu
 Teaching Associates (For LAB only) : N/A

Course Objective:

Students will acquire basic knowledge

1. To understand the difference between Renewable and non-renewable energy sources
2. To understand methods of conversion of solar energy and wind energy to other form of energy.
3. To understand methods harnessing energy from Biomass, Geothermal and ocean
4. To understand the principle of operation of Magneto Hydrodynamic power generation:
5. To understand the principle and operation of fuel cell.
6. To solve numerical problems of Renewable and non-renewable energy sources

COURSE OUTCOMES (COs):

After completion of this course the students are expected to be able to demonstrate following knowledge, skills and attitudes.

The student will be able to:

		Blooms Taxonomy Level (BTL)	Target
CO1	explain the principle of conversion of solar energy, wind energy, biomass, Geothermal energy, Ocean energy and Hydrogen energy to other form of energy.	BT 2	70% marks
CO2	explain the principle of operation of magneto hydrodynamic power generation	BT 2	65% marks
CO3	use Solar energy, Wind energy, Biomass, Geothermal energy, Ocean energy, Hydrogen energy and fuel cell for different applications.	BT 3	65% marks
CO4	suggest location to set up wind mill and biogas generation plant	BT 3	65% marks
CO5	estimate conversion efficiency of fuel cell	BT 3	65% marks
CO6	solve numerical problems relating to conversion of Solar energy, Wind energy, Biomass, Ocean energy and Hydrogen energy to heat and electric energy	BT 4	65% marks
PEEE501C			66% marks

PROGRAM OUTCOMES(POs):

PO Number	Description
1. Engineering knowledge	Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. Problem analysis	Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. Design/development of solutions	Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. Conduct investigations of complex problems	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. Modern tool usage	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. The engineer and society	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. Environment and sustainability	Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. Ethics	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. Individual and team work	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. Communication	Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. Project management and finance	Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. Life-long learning	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes (PSOs)

PSO Number	Description
PSO1	Apply science, engineering, mathematics through differential and integral calculus, complex variables to solve electrical engineering problems.
PSO2	Demonstrate proficiency in use of software & hardware to be required to practice Electrical engineering profession.

Mapping of Course Outcomes and Program Outcomes:

Course Outcomes	Program Outcomes												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	1					2			2		2	3	
CO2	2	1					1			1		1	2	
CO3	3		2			1						1		
CO4	1		1			1	1			1		1	1	
CO5	1												1	
CO6	3	2											2	
PEEE501C	2.2	1.3	1.5			1.0	1.3			1.3		1.3	1.8	

1 = courses in which the student will be exposed to a topic

2 = courses in which students will gain competency in that area

3 = courses in which students will master that skill

SYLLABUS:

Topic/Unit/Chapter	Hours(L=Lecture)	CO
Introduction to Energy sources : Renewable and non-renewable energy sources, energy consumption as a measure of Nation's development; strategy for meeting the future energy requirements Global and National scenarios, Prospects of renewable energy sources. Impact of renewable energy generation on environment, Kyoto Protocol.	03	CO1
Solar Energy : Solar radiation - beam and diffuse radiation, solar constant, earth sun angles, attenuation and measurement of solar radiation, local solar time, derived solar angles, sunrise, sunset and day length. flat plate collectors, concentrating collectors, Solar air heaters-types, solar driers, storage of solar energy-thermal storage, solar pond, solar water heaters, solar distillation, solar still, solar cooker, solar heating & cooling of buildings, photo voltaics - solar cells, different types of PV Cells, Mono-poly Crystalline and amorphous Silicon solar cells. Design of PV array. Efficiency and cost of PV systems & its applications. PV hybrid systems.	08	CO1 CO3 CO6
Wind Energy : Principle of wind energy conversion; Basic components of wind energy conversion systems; wind mill components, various types and their constructional features; design considerations of horizontal and vertical axis wind machines: analysis of aerodynamic forces acting on wind mill blades and estimation of power output; wind data and site selection considerations	05	CO1 CO3 CO4 CO6
Energy from Biomass : Biomass conversion technologies, Biogas generation plants, classification, advantages and disadvantages, constructional details, site selection, digester design consideration, filling a digester for starting, maintaining biogas production, Fuel properties of bio gas, utilization of biogas	05	CO1 CO3 CO4 CO6
Geothermal Energy : Estimation and nature of geothermal energy, geothermal sources and resources like hydrothermal, geo-pressured hot dry rock, magma. advantages, disadvantages and application of geothermal energy, prospects of geothermal energy in India.	05	CO1 CO3 CO6
Energy from Ocean : Ocean Thermal Electric Conversion (OTEC) systems like open cycle, closed cycle, Hybrid cycle, prospects of OTEC in India. Energy from tides, basic principle of tidal power, single basin and double basin tidal	05	CO1 CO3 CO6

Topic/Unit/Chapter	Hours(L=Lecture)	CO
power plants, advantages, limitation and scope of tidal energy. Wave energy and power from wave, wave energy conversion devices, advantages and disadvantages of wave energy		
Magneto Hydrodynamic power generation : Principle of MHD power generation, MHD system, Design problems and developments, gas conductivity, materials for MHD generators and future prospects	05	CO2
Hydrogen Energy : Introduction, Hydrogen Production methods, Hydrogen storage, hydrogen transportation, utilization of hydrogen gas, hydrogen as alternative fuel for vehicles	03	CO1 CO3 CO6
Fuel cell : Introduction, Design principle and operation of fuel cell, Types of fuel cells, conversion efficiency of fuel cell, application of fuel cells	03	CO5

TEXT BOOKS:

1. Renewable energy sources and conversion technology, Bansal Keemann, Meliss, Tata Mc Graw Hill.
2. Renewable energy resources and emerging technologies, D.P. Kothari, PHI.
3. Non-conventional Energy sources, G.D. Rai, Khanna Publishers.

REFERENCE BOOKS :

Non-conventional Energy, Ashok V. Desai, New Age International Publishers Ltd.

COURSE DELIVERY PLAN:

Sess. No.	CO	Topic (s)	Book No [CH No][Page No]	Teaching-Learning Methods	Planned Date	Execution Date
1		Discussion of Course outcome and program outcome. Overview of the course.		T: chalk & talk With PPT L: observes understands and necessary doubts cleared	18.07.2023	
2	CO1	Renewable and non-renewable energy sources Energy consumption as a measure of nations development	Non-conventional Energy sources, G.D. Rai, Chapter 1 Pg 1-4	T: chalk & talk With PPT L: observes understands and necessary doubts cleared	19.07.2023	
3	CO1	Strategy for meeting the future energy requirements, Global and National scenarios, Prospects of renewable energy sources.	Non-conventional Energy sources, G.D. Rai, Chapter 1 Pg 35-43	T: chalk & talk With PPT L: observes understands and necessary doubts cleared	21.07.2023	
4	CO1	Impact of renewable energy generation on environment, Kyoto Protocol	Hands out	T: chalk & talk With PPT L: observes understands and necessary doubts cleared	25.07.2023	
5	CO1 CO3 CO6	Solar radiation: beam and diffusion radiation, solar constant, earth sun angel	Non-conventional Energy sources, G.D. Rai, Chapter 2	T: chalk & talk With PPT L: observes understands	26.07.2023	

Sess. No.	CO	Topic (s)	Book No [CH No][Page No]	Teaching-Learning Methods	Planned Date	Execution Date
			Pg 47-60	and necessary doubts cleared		
6	CO1 CO3 CO6	Attenuation and measurement of solar radiation, local solar time		T: chalk & talk With PPT L: observes understands and necessary doubts cleared	28.07.2023	
7	CO1 CO3 CO6	Derived Solar angles, sunrise, Sunset and day length		T: chalk & talk With PPT L: observes understands and necessary doubts cleared	01.08.2023	
8	CO1 CO3 CO6	Flat Plate Collectors , Concentrating Collectors	Non-conventional Energy sources, G.D. Rai, Chapter 3 Pg 73-80, 102-112	T: chalk & talk With PPT L: observes understands and necessary doubts cleared	02.08.2023	
9	CO1 CO3 CO6	Solar air heater types, solar driers, storage of solar energy, thermal storage, solar pond, solar water heater	Non-conventional Energy sources, G.D. Rai, Chapter 4 Pg 81-85, 124-126, 138-142	T: chalk & talk With PPT L: observes understands and necessary doubts cleared	04.08.2023	
10	CO1 CO3 CO6	Solar distillation, Solar still, Solar cooker. Solar heating and Cooling of buildings	Hands out	T: chalk & talk With PPT L: observes understands and necessary doubts cleared	08.08.2023	
11	CO1 CO3 CO6	Photo voltaic, Solar cell, Different types of PV Cells, Mono Poly Crystalline and amorphous Silicon Solar Cell	Non-conventional Energy sources, G.D. Rai, Chapter 5 Pg 178-190	T: chalk & talk With PPT L: observes understands and necessary doubts cleared	09.08.2023	
12	CO1 CO3 CO6	Design of PV Array efficiency and cost of PV System and its application, PV Hybrid System	Hands out	T: chalk & talk With PPT L: observes understands and necessary doubts cleared	11.08.2023	
13	CO1 CO3 CO4 CO6	Principle and Wind Energy Conversion Basic Components of Wind Energy Conversion System	Non-conventional Energy sources, G.D. Rai, Chapter 6 Pg 228-238	T: chalk & talk With PPT L: observes understands and necessary doubts cleared	16.08.2023	
14	CO1 CO3 CO4 CO6	Wind mill components and Various types and their constructional Feature	Non-conventional Energy sources, G.D. Rai, Chapter 6	T: chalk & talk With PPT L: observes understands	18.08.2023	

Sess. No.	CO	Topic (s)	Book No [CH No][Page No]	Teaching-Learning Methods	Planned Date	Execution Date
			Pg 256-266	and necessary doubts cleared		
15	CO1 CO3 CO4 CO6	Design Considerations of Horizontal and Vertical Axis Wind Machines	Non-conventional Energy sources, G.D. Rai, Chapter 6 Pg 267-285	T: chalk & talk With PPT L: observes understands and necessary doubts cleared	22.08.2023	
16	CO1 CO3 CO4 CO6	Analysis of Aerodynamic forces acting on Wind Mill blades and Estimations of Power output	Non-conventional Energy sources, G.D. Rai, Chapter 6 Pg 285-291	T: chalk & talk With PPT L: observes understands and necessary doubts cleared	23.08.2023	
17	CO1 CO3 CO4 CO6	Wind data and site selection Consideration	Non-conventional Energy sources, G.D. Rai, Chapter 6 Pg 252-255	T: chalk & talk With PPT L: observes understands and necessary doubts cleared	25.08.2023	
18	CO1 CO3 CO4 CO6	Biomass Conversion Technologies	Non-conventional Energy sources, G.D. Rai, Chapter 7 Pg 313-327	T: chalk & talk With PPT L: observes understands and necessary doubts cleared	29.08.2023	
19	CO1 CO3 CO4 CO6	Biogas generation Plant.- Classification, advantages disadvantages and constructional details	Non-conventional Energy sources, G.D. Rai, Chapter 7 Pg 327-341	T: chalk & talk With PPT L: observes understands and necessary doubts cleared	30.08.2023	
20	CO1 CO3 CO4 CO6	Properties and Utilization of Biogas			01.09.2023	
21	CO1 CO3 CO4 CO6	Site Selection and digester design consideration Filling a digester for Starting, maintaining Biogas Production	Non-conventional Energy sources, G.D. Rai, Chapter 7 Pg 365-380	T: chalk & talk With PPT L: observes understands and necessary doubts cleared	05.09.2023	
22	CO1 CO3 CO4 CO6				06.09.2023	
23	CO1 CO3 CO6	Estimation and Nature of Geothermal Energy Geothermal Resources	Non-conventional Energy sources, G.D. Rai, Chapter 8 Pg 439-445	T: chalk & talk With PPT L: observes understands and necessary doubts cleared	08.09.2023	
24	CO1 CO3 CO6	Application of geothermal energy	Non-conventional Energy sources, G.D. Rai, Chapter 8 Pg 477-481	T: chalk & talk With PPT L: observes understands and necessary doubts cleared	12.09.2023	
25	CO1 CO3 CO6				13.09.2023	
26	CO1 CO3 CO6	Advantages, disadvantages, Prospect of Geothermal Energy in India	Non-conventional Energy sources, G.D. Rai, Chapter 8	T: chalk & talk With PPT L: observes understands	15.09.2023	

Sess. No.	CO	Topic (s)	Book No [CH No][Page No]	Teaching-Learning Methods	Planned Date	Execution Date
			Pg 487-490	and necessary doubts cleared		
27	CO1 CO3 CO6	OTEC systems like Open cycle and Closed Cycle and Hybrid Cycle Systems, Prospects of OTEC in India	Non-conventional Energy sources, G.D. Rai, Chapter 9 Pg 497-510	T: chalk & talk With PPT L: observes understands and necessary doubts cleared	19.09.2023	
28	CO1 CO3 CO6	Energy From Tides, Basic Principle of Tidal Power Generation, Single Basin and Double Basin Tidal Power Plants advantage, limitation and Scope of Tidal Power	Non-conventional Energy sources, G.D. Rai, Chapter 9 Pg 510-516, 521-532	T: chalk & talk With PPT L: observes understands and necessary doubts cleared	20.09.2023	
29					22.09.2023	
30	CO1 CO3 CO6	Wave Energy and Power From Wave Wave Energy Conversion devices and Advantage, Disadvantages of Wave Energy	Non-conventional Energy sources, G.D. Rai, Chapter 9 Pg 533-541	T: chalk & talk With PPT L: observes understands and necessary doubts cleared	26.09.2023	
31	CO2	Principle of MHD Power Generation	Non-conventional Energy sources, G.D. Rai, Chapter Pg	T: chalk & talk With PPT L: observes understands and necessary doubts cleared	27.09.2023	
32	CO2	MHD System	Non-conventional Energy sources, G.D. Rai, Chapter 12 Pg 667-675	T: chalk & talk With PPT L: observes understands and necessary doubts cleared	29.09.2023	
33	CO2	Design problems and developments.	Non-conventional Energy sources, G.D. Rai, Chapter 12 Pg 676-677	T: chalk & talk With PPT L: observes understands and necessary doubts cleared	03.10.2023	
34	CO2	Gas Conductivity Materials for MHD generation, Future Prospects	Non-conventional Energy sources, G.D. Rai, Chapter 12 Pg 682-687	T: chalk & talk With PPT L: observes understands and necessary doubts cleared	04.10.2023	
35	CO1 CO3 CO6	Introduction, Hydrogen Production Methods	Non-conventional Energy sources, G.D. Rai, Chapter 11 Pg 613-627	T: chalk & talk With PPT L: observes understands and necessary doubts cleared	06.10.2023	
36	CO1 CO3 CO6	Hydrogen storage, hydrogen transportation	Non-conventional Energy sources, G.D. Rai, Chapter 11	T: chalk & talk With PPT L: observes understands	10.10.2023	

Sess. No.	CO	Topic (s)	Book No [CH No][Page No]	Teaching-Learning Methods	Planned Date	Execution Date
			Pg 637-642	and necessary doubts cleared		
37	CO1 CO3 CO6	Utilization of Hydrogen Gas, Hydrogen as a Alternative Fuel For Vehicle.	Non-conventional Energy sources, G.D. Rai, Chapter 11 Pg 643-650	T: chalk & talk With PPT L: observes understands and necessary doubts cleared	11.10.2023	
38	CO5	Introduction, Design Principle and Operation of Fuel Cell	Non-conventional Energy sources, G.D. Rai, Chapter 10 Pg 561-565	T: chalk & talk With PPT L: observes understands and necessary doubts cleared	13.10.2023	
39	CO5	Types of fuel cells	Non-conventional Energy sources, G.D. Rai, Chapter 10 Pg 566-574	T: chalk & talk With PPT L: observes understands and necessary doubts cleared	17.10.2023	
40	CO5	Conversion efficiency of Fuel Cell and application of Fuel Cell.	Non-conventional Energy sources, G.D. Rai, Chapter 10 Pg 575-579	T: chalk & talk With PPT L: observes understands and necessary doubts cleared	18.10.2023	

LIST OF TUTORIALS: OPTIONAL

Tutorial session no	Topics	CO-Mapping
	NA	

WEEKLY HOMEWORK ASSIGNMENTS/ PROBLEM SETS/OPEN ENDED PROBLEM-SOLVING EXERCISES etc.

Week	Assignment/Quiz	Topic	Details	CO
3	Quiz-1 and PPT	Introduction to Energy sources	Renewable and non-renewable energy sources, energy consumption as a measure of Nation's development; strategy for meeting the future energy requirements Global and National scenarios, Prospects of renewable energy sources. Impact of renewable energy generation on environment, Kyoto Protocol.	CO1
4	Assignment -1	Solar radiation: beam and diffusion radiation, solar constant, earth sun angel Attenuation and measurement of solar radiation, local solar time Derived Solar angles, sunrise, Sunset and day length	Problem solving on solar geometry	CO1 CO3 CO6

5	Report Writing	Reporting to be done based on a topic related to renewable energy	The topic of report is to be selected by the student. Necessary research work is to be carried out and report is to be prepared which will be evaluated based on a rubric.	CO2, CO3, CO4 & CO5
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COURSE TIME TABLE

	Lecture	Practical
Monday		
Tuesday	11.40 AM TO 12.30 PM	
Wednesday	10.00 AM TO 10.50 AM	
Thursday		
Friday	10.50 PM TO 11.40 AM	
Saturday		

REMEDIAL CLASSES:

Supplement course handout, which may perhaps include special lectures and discussions that would be planned, and schedule notified accordingly.

DELIVERY DETAILS OF CONTENT BEYOND SYLLABUS:

Content beyond syllabus covered (if any) should be delivered to all students that would be planned, and schedule notified accordingly.

S.No	Advanced Topics, Additional Reading, Research papers and any	CO	POs & PSOs	ALM	References
1	Concept of Deregulated power system & integration of wind energy	CO1	PO1, PO7 & PO12 & PSO 1	Lecture	Online resources
2	Estimation of PV capacity using online tool.	CO1, CO3	PO1, PO3, PO5 & PO12 & PSO 1	Hands on & PPT	Online resources

EVALUATION: AS PER MAKAUT GUIDELINES

Schedule for Continuous Assessment (CA):

CA	Assessment By	Schedule
CA-I	Presentation, Quiz, Group Discussion	As per Academic Calendar
CA-II	Report writing	
CA-III	Class test in pen and paper mode to be conducted at the College Level	
CA-IV	Centralized online test to be arranged by the University	

ATTENDANCE POLICY

Every student is expected to be responsible for regularity of his/her attendance in class rooms and laboratories, to appear in scheduled tests and examinations and fulfil all other tasks assigned to him/her in every course. For Promotion, a Minimum of 50% of internal marks must be obtained. In every course, student has to maintain a minimum of 75% attendance to be eligible for appearing in Semester end examination of the course, for cases of medical issues and other unavoidable circumstances the students will be condoned if their attendance is between 60% to 75% in every course.

subjected to submission of medical certificates, medical case file and other needful documental proof to the concerned departments.

DETENTION POLICY


In any course, a student has to maintain a minimum of 75% attendance and must secure a minimum of 50% marks in In-Semester Examinations to be eligible for appearing to the Semester End Examination, failing to fulfill these conditions will deem such student to have been detained in that course.

PLAGIARISM POLICY

Use of unfair means in any of the evaluation components will be dealt with strictly, and the case will be reported to the examination committee.

COURSE TEAM MEMBERS, CHAMBER CONSULTATION HOURS AND CHAMBER VENUE DETAILS:

Each instructor will specify his / her chamber consultation hours during which the student can contact him / her in his / her chamber for consultation.

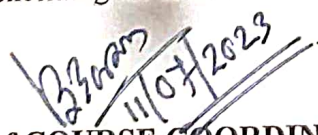
S.No.	Name of Faculty	Chamber Consultation Day (s)	Chamber Consultation Timings for each day	Chamber Consultation Room No:	Signature of Course faculty
	J.B. BASU	Monday	1.20 PM TO 1.45 PM & 4.40 PM TO 5.30 PM	Office of OSD, Examinations. 3rd Floor, Main Building	
	J.B. BASU	Wednesday	1.20 PM TO 1.45 PM & 4.40 PM TO 5.30 PM	Office of OSD, Examinations. 3rd Floor, Main Building	
	J.B. BASU	Thursday	1.20 PM TO 1.45 PM & 4.40 PM TO 5.30 PM	Office of OSD, Examinations. 3rd Floor, Main Building	

GENERAL INSTRUCTIONS

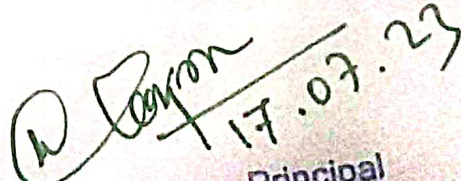
Students should come prepared for classes and carry the text book(s) or material(s) as prescribed by the Course Faculty to the class.

NOTICES

All notices will be communicated through the institution email.
All notices concerning the course will be displayed on the respective Notice Boards.


Signature of COURSE COORDINATOR:


17/07/23
HEAD OF DEPARTMENT: Head of the Department
Department of Electrical Engineering
Siliguri Institute of Technology


17.07.23
Principal
Siliguri Institute of Technology

Approval from: Head of the Institutions
(Sign with Office Seal)