Course Plan

School	Engineering
Department	Energy
Course Code	EN538
Course Name	Hybrid Renewable Energy System Design
Session	Spring 2024
Credit	3
Instructor	Sadhan Mahapatra

Abstract

Hybrid renewable energy-based systems offer a promising opportunity to use locally available renewable energy sources and provide clean energy services to remote communities. This course aims to help students understand the important role of decentralized energy systems in achieving energy security and access to clean energy in villages. Optimal design models are necessary to ensure that the cost of energy generation is minimal. The course covers hybrid energy system design and development using simulation tools, microgrid concepts, and case studies to familiarize students with the practical issues of the energy access program.

Objectives

- To demonstrate the concept of distributed generation, scope and challenges in off-grid system implementation.
- To use advanced system analysis, modeling and design tools like HOMER to design and develop hybrid power generation system.
- To analyze the rural energy availability and planning, impact of energy access to livelihood improvement of the community.

Course Outcomes

CO1: Understanding characteristics of renewable energy sources for effective integration
CO2: Design hybrid energy system with control strategies for operation
CO3: Assess performance of hybrid energy system using simulation tools

Prerequisites of the course

Nil

Lecture Plan

Lecture	Topic(s)
1	Concepts of Hybrid Energy System
2-3	Load estimation, variability and profile of a village, complexity and critical of loads
4-6	Renewable Energy Systems for Power Generation; Understanding on the input parameters variability
7	Sensitivity of various parameters on RE based Systems for Power Generation
8-10	Economic aspects: System capital and operating cost, cost of energy generation, concepts of Net Present Value, Cost Recovery Factor
11-12	Case studies of RE base systems economic analysis

13-14	Energy storage systems, Diesel Generator, charge controller, inverter
15-17	HOMER simulation tool: design aspects, system configurations, analysis
18	RE systems component selection and optimum configuration
19	RE system and grid base system configurations
20-21	System configurations optimization for a typical village load profile
22-25	Sensitivity analysis of the cost parameters; Sample problems and case studies
26-29	Simulation tool: HOMER, RETSCREEN
30-31	Grid interactive and grid connected hybrid energy systems
32	Grid interactive inverter, islanding, reverse power flow, surge protection
33	Renewable energy based Micro-grid
34	Linkages with rural livelihoods, rural industries and social development
35-36	Case studies on various distributed energy generation systems

Pedagogy

- Teaching-learning methods to be used o Classroom lectures
- Case studies Presentation
- Design and system simulation in HOMER, RETSCREEN simulation tools

Evaluation Plan

Course Outcomes	**CO1**		**C02**		**CO3**	
Weightage (%)	40		40		20	
Marks	60.0		60.0		30.0	
Course Outcomes	**Weightage of Marks (%)**	**Test I (25)**	**Mid Term Test (40)**	**Test II (25)**	**Semester End (60)**	**Total (150)**
CO1	40	25	5		30	60
C02	40		30		30	60
CO3	20		5	25		30
Total	100	25	40	25	60	150

Assessment Criteria			**Marks distribution**				
Bloom Taxonomy	**Level**	**Marks Weightage (%)**	**Marks**	**Test I (25)**	**Mid Term Test (40)**	**Test II (25)**	**Semester End (60)**
Knowledge	Easy	10	15	5	5		5
Understanding	Easy	10	15	5	5		5
Application	Average	30	45	15	15		15
Analysis	Above average	30	45		10	15	20
Synthesis	Difficult	12	18			10	8
Evaluation	Difficult	8	12		5		7
TOTAL		**100**	**150**	**25**	**40**	**25**	**60**

Expected outcome

On completion of this course, the students will

- Have acquired an understanding on the concept on hybrid renewable energy base systems, energy access to rural areas, RE base systems for livelihood improvement
- Be able to demonstrate their learning about use of simulation tools for optimum system configurations.

Suggested Reading Materials

[1] Sahoo U. Hybrid Renewable Energy Systems. Wiley-Scrivener; 1st edition, 2021

[2] Bhattacharyya C. S. and Palit D. (2014). Mini-Grids for Rural Electrification of Developing Countries. Springer

[3] Bhattacharyya S. (Ed.) (2013); Rural electrification through decentralised Off-grid systems in Developing Countries, Springer

[4] Fu Y., Yang J. and Zuo T. (2011); Optimal sizing design for hybrid renewable energy systems in Rural Areas, Springer

[5] Kabalci E. (Ed) (2021). Hybrid Renewable Energy Systems and Microgrids. Academic Press