EE4101: SUSTAINABLE ENERGY SYSTEMS

Effective Term
Semester A 2022/23

Part I Course Overview

Course Title
Sustainable Energy Systems

Subject Code
EE - Electrical Engineering
Course Number
4101

Academic Unit
Electrical Engineering (EE)

College/School
College of Engineering (EG)

Course Duration
One Semester

Credit Units
3

Level
B1, B2, B3, B4 - Bachelor's Degree

Medium of Instruction
English

Medium of Assessment
English

Prerequisites
EE3110 Analogue Electronic circuits or
EE3122 Analogue Circuit Fundamentals

Precursors
Nil

Equivalent Courses
Nil

Exclusive Courses
Nil

Part II Course Details

Abstract

The aim of this course is to provide students with an understanding of the concepts / techniques / basic principles of power conversion techniques and their applications.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Recognize and differentiate different state-of-the-art energy generation, conversion, storage and utilization technologies		x	x	
2	Analyze different architectures for energy conversion, storage, and utilization		x	x	
3	Design systems for real-life applications		x	x	

A1: Attitude
Develop an attitude of discovery/innovation/creativity, as demonstrated by students possessing a strong sense of curiosity, asking questions actively, challenging assumptions or engaging in inquiry together with teachers.

A2: Ability
Develop the ability/skill needed to discover/innovate/create, as demonstrated by students possessing critical thinking skills to assess ideas, acquiring research skills, synthesizing knowledge across disciplines or applying academic knowledge to real-life problems.

A3: Accomplishments
Demonstrate accomplishment of discovery/innovation/creativity through producing /constructing creative works/new artefacts, effective solutions to real-life problems or new processes.

Teaching and Learning Activities (TLAs)

	TLAs	Brief Description	CILO No.	Hours/week (if applicable)
1	Lectures	Key concepts are described, illustrated, and applied. Students will be taught how to apply the techniques discussed in lectures.	1, 2, 3	3 hrs/wk
2	Tutorial	Design projects on renewable energy systems.	1, 2, 3	1 hr/wk

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks (e.g. Parameter for GenAI use)
1	Tests (min.: 2)	1, 2, 3	35	
2	#Assignments (min.: 3)	1, 2, 3	15	

Continuous Assessment (%)

50

Examination (%)
50

Examination Duration (Hours)
2

Additional Information for ATs
Remark:
To pass the course, students are required to achieve at least 30% in course work and 30% in the examination.

may include homework, exercise, project/mini-project, presentation

Assessment Rubrics (AR)

Assessment Task
Examination

Criterion
Achieving all CILOs

Excellent (A+, A, A-)
High

Good (B+, B, B-)
Significant

Fair (C+, C, C-)
Moderate

Marginal (D)
Margin

Failure (F)
Not even reaching marginal

Assessment Task
Coursework

Criterion
Achieving all CILOs

Excellent (A+, A, A-)
High

Good (B+, B, B-)
Significant

Fair (C+, C, C-)
Moderate

Marginal (D)
Margin

Failure (F)
Not even reaching marginal

Part III Other Information

Keyword Syllabus

Electrical System and Pollution
Electrical transmission system. High-voltage AC and DC Transmission. Power Quality. Electromagnetic compatibility. Power factor. Displacement factor. Distortion factor. Voltage Sags and Swells. Active and Passive Power Filters. Dynamic Voltage Restorers. Uninterruptible power supply. Flexible AC Transmission.

Smart Grids
National and local electricity consumption. Global distribution of renewable energy resources. Definition of Smart Grids. Microsource control. Energy Management Network. Smart Metering Infrastructure. Protection Control. Smart Grid Economics.

Photovoltaic (PV) Systems
Current PV technologies. Cell efficiencies. Circuit Models. Maximum Power Point (MPP). Irradiance and temperature Effects. Partial Shading. Local and global MPP tracking. PV system classification. Requirements of off-grid and on-grid PV inverters. Islanding.

Wind Power Systems
Global cumulative wind power capacity. Turbine dimension and power rating. Betz' s limit. Power coefficient and tip speed. Electrical power versus wind speed. Cut-in, rated, and cut-out wind speeds. Control structure of a wind turbine. Fixed speed operation. Double-fed induction generator. Converter-connected structure. Off-grid and on-grid systems.

Fuel Cell Technology
Basic operation. Different types of fuel cells - Proton Exchange Membrane, Alkali, Phosphoric acid, and Solid oxide fuel cells. Static and transient characteristics. Fuel starvation. Transient compensation.

Battery Technology
Battery chemistry. Solid electrolyte battery. Battery geometry. Characterization. Memory effect. Hysteresis characteristics. State-of-charge and state-of-health. Cell balancing. Battery modeling. Electrochemical impedance spectroscopy. Single and double pulse testing.

Reading List

Compulsory Readings

	Title
1	Jean-Claude Sabonnadiere, Renewable Energies, London: ISTE Ltd.; Hoboken, NJ: John Wiley & Sons, 2009.
2	Bollen, Math H. J., Smart grid : adapting the power system to new challenges, San Rafael, California : Morgan & Claypool Publishers, 2011.
3	John R. Shaw Balfour, Nash Michael, Bremer Nicole, Advanced photovoltaic system design, Burlington, Mass. : Jones & Bartlett Learning, 2013.
4	Ted R Moore and Ewarld I Bailey, Wind power : systems engineering applications and design models, Hauppauge, N.Y. : Nova Science Publishers, c2012.
5	Ryan O'Hayre, Suk-Won Cha, Whitney Colella, and Fritz B Printz, Fuel Cell Fundamentals, 3rd ed. Somerset : Wiley, 2016.
6	Bruno Scrosati, K. M Abraham, and Walter A. van Schalkwijk, Lithium batteries : advanced technologies and applications, Hoboken, NJ : John Wiley & Sons, Inc., c2013.

Additional Readings

	Title
1	Technology Roadmap: Smart Grids, International Energy Agency, 2011.
2	Geoff Stapleton and Susan Neill, Grid-Connected Solar Electric Systems : The Earthscan Expert Handbook for Planning, Design and Installation, Routledge, 2012.