EE4147: GRID-CONNECTED POWER CONVERTERS

Effective Term
Semester A 2025/26

Part I Course Overview

Course Title
Grid-Connected Power Converters

Subject Code
EE - Electrical Engineering
Course Number
4147

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

Power electronics is an integral part of electronic equipment in household appliances, renewable energy systems, transportation systems, industrial automation, and advanced transmission and distribution systems. This course provides the working principles and design for grid-connected power converters, and gives the students the background needed to be successful in these high-demand areas. After reviewing some basics of power electronics and study circuits with diodes and thyristors, the course introduces power rectifier and power inverter topologies, and explains control principles and design considerations. A grid-connected power inverter is studied in detail operating with voltage-oriented control. The course concludes with practical applications of the studied power converters and control techniques.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Identify different power converter topologies and explain their operational principles.		x	x	
2	Analyze a three-phase grid-connected power system and its control		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.

Learning and Teaching Activities (LTAs)

	LTAs	Brief Description	CILO No.	Hours/week (if applicable)
1	Lectures	Students will engage in formal lectures to gain knowledge of power electronics technologies and develop the ability to analyze the operation and control of power converters through instructor-led explanations and discussions.	1, 2, 3	2 hrs/wk

2	Tutorial	Students will apply key concepts of power electronics to solve problems and explore various applications through guided exercises and discussions.	1, 2, 3	1 hr/wk

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks ("-" for nil entry)	Allow Use of GenAI?
1	Tests (min.: 2)	1, 2, 3	30	-	No
2	#Assignments (min.: 2)	1, 2, 3	20	-	Yes

Continuous Assessment (%)

50

Examination (%)

50

Examination Duration (Hours)

2

Minimum Continuous Assessment Passing Requirement (%)

30

Minimum Examination Passing Requirement (%)

30

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

Introduction and Review of Fundamentals

Power electronics and applications. Review of circuit analysis fundamentals and power calculations. Models of power converters. Grid-connected power converters.

Circuits with Diodes

Diode models. Analysis of circuits with diodes. Single-phase rectifiers. Rectifier parameters. Filter capacitor. DC power supplies.

Circuits with Thyristors

Thyristor or Silicon Controlled Rectifier (SCR). Resistive load. Inductive load. R-L load. Bidirectional AC switch.

Single-Phase Controlled Rectifiers

Thyristor-based rectifiers. Single-phase semi-controlled rectifiers. Single-phase fully controlled rectifier.

Three-Phase Rectifiers

Three-phase half-wave rectifiers. Three-phase full-wave diode rectifier. Three-phase semi-controlled rectifier. Three-phase fully controlled rectifier

Power Inverters

Single-phase inverters. Square-wave modulation. Single-pulse pulse-width modulation (PWM). Sinusoidal PWM. Selective harmonic elimination (SHE). Three-phase inverters.

Control of a Grid-Connected Power Inverter

Model of a grid-connected three-phase power inverter. Clarke and Park’s transformations. Voltage-oriented control. Phase-locked loop (PLL). Space-vector modulation.

Applications

Examples of grid-connected power converters for different applications: Power quality, renewables, energy storage, and high-voltage DC transmission.

Reading List

Compulsory Readings

	Title
1	Ned Mohan, Tore M. Undeland and William P. Robbins, "Power Electronics: Converters, Applications and Design," 3rd Edition, John Wiley, 2003.
2	Rashid M H, "Power Electronics: Circuits, Devices & Applications," 3rd Edition, Pearson/Prentice Hall, 2004.

Additional Readings

	Title
1	Zhenyu Yu "Space-Vector PWM With TMS320C24x/F24x Using Hardware and Software Determined Switching Patterns," Texas Instruments, Application Report SPRA524 https://www.ti.com/lit/an/spra524/spra524.pdf?ts=1734589792074&ref_url=https%253A%252F%252Fwww.google.com%252F