

25UEET402	POWER ELECTRONICS	Category	L	T	P	R	Credit	Year of Introduction
		PCC	3	1	0	0	4	2025

Preamble: This course introduces students to power semiconductor devices, their characteristics, and switching behavior. It also covers the operation, analysis, and applications of various power converters, enabling students to understand and design efficient power electronic systems for practical electrical and electronic applications.

Prerequisite: IEE 104 Introduction to Electrical and Electronics Engineering

Course Outcomes: After the completion of the course, the student will be able to:

CO	Course Outcomes	Knowledge Level
CO1	Apply the operating principles and characteristics of modern power semiconductor devices to analyze controlled rectifier circuits.	K3 Apply
CO2	Apply the principles of AC voltage controllers and DC-DC converters to analyze their performance in practical applications.	K3 Apply
CO3	Apply inverter principles and PWM techniques to determine the performance of power electronic systems.	K3 Apply
CO4	Apply drive schemes and control methods to analyze the operation of AC and DC motor drives.	K3 Apply

Mapping of course outcomes with program outcomes and program specific outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	2	-	-	-	-	-	-	-	2	1	-
CO2	3	3	-	2	-	-	-	-	-	-	2	1	1
CO3	3	3	2	2	-	-	-	-	-	-	2	3	2
CO4	3	3	2	2	-	-	-	-	-	-	2	3	3
Avg	3	3	2	2	-	-	-	-	-	-	2	2	2

Mapping of course outcomes with Knowledge and Attitude Profile (WK)

	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1	*	*	*	*	*	-	-	*	-
CO2	*	*	*	*	-	-	-	*	-
CO3	*	*	*	*	*	-	-	*	-
CO4	*	*	*	*	*	-	-	*	-

Wks Mapped with the course

WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
*	*	*	*	*	-	-	*	-

Mark Distribution:

Total Marks	CIE Marks	ESE Marks	ESE Duration
100	40	60	2.5 Hours

Continuous Internal Evaluation Pattern:

Attendance	: 5 marks
Continuous Assessment Test	: 20 marks
Continuous Assessment Assignment	: 15 marks

SYLLABUS

Module 1 (14 Hours)

Introduction to Power Electronics: Principle of operation and characteristics of power semiconductor devices: Power diode, Power MOSFET and IGBT – switching characteristics and comparison. SCR: Static and switching characteristics (turn-on and turn-off), di/dt and dv/dt protection, turn-on methods, two transistor analogy. Gate triggering circuits: Requirements of isolation and synchronization in gate drive circuits

Module 2 (14 Hours)

Single-phase controlled rectifiers: Half-wave-controlled rectifier with R load. Fully controlled and half-controlled bridge rectifiers with R, RL and RLE loads – continuous and discontinuous conduction modes – output voltage equations and simple problems. Three-phase controlled rectifiers: Three-phase half-wave-controlled rectifier with R load. Fully controlled and half-controlled bridge converters with RLE load (continuous conduction, ripple-free operation) – output voltage equations – waveforms for various triggering angles.

Module 3(14 Hours)

Voltage Source Inverters (VSI): Single-phase half-bridge and full-bridge inverters with R and RL loads.

Three-phase bridge inverter with R load – 120° and 180° conduction modes. Current Source Inverters (CSI): Single-phase capacitor commutated CSI – basic operation. Pulse Width Modulation (PWM) techniques. Modulation index and frequency modulation ratio. DC–DC converters (Choppers): Step-down and step-up choppers. Switching regulators: Buck, Boost and Buck-Boost

Module 4 (14 Hours)

Basic introduction to cycloconverters, definition and working principle. Types of cycloconverters: step-up and step-down, single-phase and three-phase cycloconverters. Basic operation of single-phase cycloconverters with simple configurations. Concept of positive and negative group operation and basic output waveforms. control methods: phase angle control and basic idea of circulating and non-circulating current modes. Basic performance aspects: output frequency range, harmonics, power factor, and efficiency. Applications of cycloconverters in AC drives, heating, and industrial systems.

Text Books:

1. Rashid, M. H. (2014). *Power electronics: Circuits, devices, and applications*. Pearson Education.
2. Hart, D. W. (2010). *Power electronics*. Tata McGraw-Hill Education.
3. Bimbhra, P. S. (2022). *Power electronics*. Khanna Publishers.

Reference Books:

1. Mohan, N., Undeland, T. M., & Robbins, W. P. (2007). *Power electronics: Converters, applications, and design*. Wiley India.
2. Erickson, R. W., & Maksimović, D. (2012). *Fundamentals of power electronics*. Springer.
3. Krein, P. T. (1998). *Elements of power electronics*. Oxford University Press.
4. Umanand, L. (2009). *Power electronics: Essentials and applications*. Wiley India.
5. Singh, M. D., & Khanchandani, K. B. (2008). *Power electronics*. Tata McGraw-Hill.
6. Vithayathil, J. (1995). *Power electronics: Principles and applications*. McGraw-Hill College.

END SEMESTER EXAMINATION – MODEL QUESTION PAPER (STC 2025 SCHEME)

Course Code	25UEET402
Course Name	POWER ELECTRONICS
Max. Marks: 60	Duration: 2.5 Hours

Part A

(Answer all questions. Each question carries 3 marks)

Qn No.	Question	Marks	CO	B L
1	Explain the operating regions of an SCR using its static V–I characteristics, including latching current and holding current.	3	1	L2
2	Describe the requirements of isolation in gate drive circuits.	3	1	L2
3	Differentiate continuous and discontinuous conduction modes in controlled rectifiers.	3	2	L2
4	Explain the ripple-free operation criteria in a three-phase half-controlled bridge converter.	3	2	L2
5	Differentiate between the 120° and 180° conduction modes of a three-phase bridge inverter.	3	3	L2
6	Describe the significance of the modulation index in Pulse Width Modulation (PWM) techniques.	3	3	L2
7	Differentiate between step-up and step-down cyclo -converters	3	4	L2
8	Describe the operation of a single-phase cyclo-converter with the help of a simple block diagram.	3	4	L2

Part B

(Answer any one full question from each Module. Each carry 9 marks)

Module I

Qn No.	Question	Marks	CO	B L
9.a	Illustrate the dynamic switching characteristics of a Power MOSFET during its turn-on and turn-off intervals.	5	1	L3
9.b	Explain the two-transistor analogy of an SCR with the necessary equations.	4	1	L2

OR

10.a	Illustrate the structural features of power MOSFET with a neat sketch	5	1	L3
10.b	Explain different turn on methods of SCR	4	1	L2

Module II

Qn No.	Question	Marks	CO	B L
11.a	A single-phase fully controlled bridge rectifier is fed from a 230 V, 50 Hz single- phase AC supply. Assuming the firing angle is delayed to $\alpha = 45^\circ$ and the load is highly inductive with a total resistance of 10 Ω . Compute the average output voltage and average output current under continuous conduction	5	2	L3
11.b	Illustrate the input voltage, output voltage, and output current waveforms of a single-phase half-wave-controlled rectifier feeding a purely resistive (R) load.	4	2	L3

OR				
12.a	Illustrate the output voltage waveforms of three phase fully controlled converter with RLE load for firing angles i) $\alpha = 0^\circ$ and ii) $\alpha = 60^\circ$.	5	2	L3
12.b	A single-phase half-controlled bridge rectifier supplies an RL load from a 230 V, 50 Hz AC source. Determine the load voltage and current waveforms for a firing angle of 60° .	4	2	L3
Module III				
Qn No.	Question	Marks	CO	B L
13. a	A three-phase bridge inverter operates in 180° conduction mode with a balanced R load. Construct the line-to-line output voltage waveforms and calculate the phase voltages.	5	3	L3
13. b	Explain the working principle and operation of a single-phase full-bridge voltage source inverter operating with an RL load.	4	3	L2
OR				
14. a	A step-down chopper is supplied with 200 V DC and operated at a duty cycle of 0.4. Compute the average output voltage and explain the converter operation.	5	3	L3
14. b	Distinguish a Buck converter and a Boost converter based on their structural circuit configurations and output voltage expressions.	4	3	L2
Module IV				
Qn No.	Question	Marks	CO	B L
15. a	A single-phase step-down cyclo-converter is used to obtain a 10 Hz output from a 50 Hz AC source. Apply the working principle of the cyclo-converter to determine the generation of the low-frequency output waveform using positive and negative converter groups	5	4	L3
15. b	A single-phase cyclo-converter is used to supply a resistive load requiring a lower output frequency than the input supply. Apply the operating principles of the cyclo-converter to determine the firing sequence and firing angles required to obtain the desired output frequency.	4	4	L3
OR				
16. a	A three-phase industrial drive requires a variable-frequency AC supply for speed control. Determine a suitable cyclo-converter configuration to meet the requirement.	5	4	L3
16. b	A cyclo-converter is used to supply a variable-speed AC motor in an industrial drive. Determine the effect of harmonics on the converter performance in terms of output voltage quality,	4	4	L3

	power factor, and efficiency.			
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