Nirma University

Institute:	**Institute of Technology**
Name of Programme:	**BTech in Electrical Engineering**
Semester:	**VI**
Course Code:	**3EE307ME24**
Course Title:	**Control of Power Electronic Converters**
Course Type:	**Department Elective-II**
Year of Introduction:	**2024 –25**

L	T	Practical component				C
		LPW	PW	W	S	
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Course Learning Outcomes (CLOs):

At the end of the course, the students will be able to -

1. apply concepts of control system in power converter control **(BL3)**
2. evaluate suitable control technique for power converter **(BL4)**
3. design and simulate power converters with advanced controllers **(BL5)**
4. develop the power converter control in real time applications **(BL5)**

Contents : **Teaching Hours: 45**

Unit-I **Controller Design Techniques and DC-DC Converter Control** **15**

Transfer function-based controller design – Bode plot, state space equation-based controller design – full state feedback, full state feedback with estimator-estimator design, output feedback, optimal control – linear quadratic, optimal estimator – Kalman filter,

Introduction to voltage mode control and current mode control, average current control mode – design of average current controller, peak current control mode – introduction, fixed frequency and variable frequency control

Unit-II **Control of DC to AC Converter** **07**

Pulse-width-modulated inverters – sine-triangle modulation, unipolar and bipolar schemes, square wave inverters, Selective Harmonic Elimination (SHE), third harmonic injection PWM

Unit-III **Current Controlled PWM for Converters** **05**

Different types of current controlled PWM techniques - linear control, hysteresis control, predictive control, and delta modulation current regulator

Unit-IV **Voltage Controlled PWM for Converters** **07**

Advantages of voltage controlled PWM techniques, modulating function techniques: cosinusoidal function, harmonic modulating function, trapezoidal modulating function, Space Vector PWM – Voltage space phasor structure, analysis, overmodulation, bus clamping modulation

Unit-V **Control of Multilevel Converters** **11**

Carrier based PWM schemes: phase shifted multi-carrier modulation, level shifted multi-carrier modulation, overmodulation of cascaded H-bridges, control of dc

bus voltages of the H-bridges, three level inverter: converter configuration, switching states, carrier based PWM: naturally sampled PD PWM, APOD and POD PWM; space vector modulation: modulator for selecting switching states, decomposition method, neutral point voltage control

Self-Study:

The self-study contents will be declared at the commencement of semester. Around 10 % of the questions will be asked from self-study contents.

Laboratory Work:

This shall consist of at least 10 practical / simulations based on the above syllabus.

Suggested Reading:

1. Ned Mohan, Tore M. Undeland and William P. Robbins, Power Electronics: Converters, Applications and Design, John Wiley & Sons, Inc., New York
2. L Umanand, Power Electronics, Essentials & Applications, Wiley India
3. D. G. Holmes and T. A. Lipo, Pulse Width Modulation for Power Converters: Principles and Practice, IEEE press and Wiley Interscience, USA
4. L. Corradini, D. Maksimovic, P. Mattavelli and R. Zane, Digital Control of High-frequency Switched-Mode Power Converters, IEEE press and Wiley, USA
5. Frede Blaabjerg, Control of Power Electronic Converters and Systems, Academic Press, Elsevier.
6. V. Ramnarayan, Course Material on Switched Mode Power Conversion
7. Abraham Pressman, Switching Power Supply Design, McGraw Hill professional.
8. Research papers and articles from reputed Journals.

Suggested List of Experiments:

	Title of Experiment	Hrs.
1.	Design and simulation of controller for power converters.	2
2.	Simulation and analysis of buck converter using voltage control mode.	2
3.	Simulation and analysis of boost converter using current control mode.	2
4.	Simulation and analysis of dc-dc converter using hysteresis current control (Closed loop).	2
5.	Design and simulation of dc-dc converter using average current control technique	2
6.	Simulation and analysis of dc-dc converter using predictive control (Closed loop).	2
7.	Simulation and analysis of dc-ac converter using voltage controlled PWM techniques.	2
8.	Simulation and analysis of dc-ac converter using current controlled PWM techniques.	2
9.	Analysis of two-level inverter controlled by trapezoidal modulating function controller	2
10.	Analysing overmodulation performance of two-level inverter	2
11.	Simulation and analysis of multilevel inverter using multi-carrier PWM techniques	4

L = Lecture, T = Tutorial, P = Practical, C = Credit