ANNAMACHARYA UNIVERSITY

(ESTD UNDER AP PRIVATE UNIVERSITIES (ESTABLISHMENT AND REGULATION) ACT, 2016)

(UNIVERSITY LISTED IN UGC AS PER THE SECTION 2(f) OF THE UGC ACT, 1956)

RAJAMPET, Annamayya District, AP – 516126, INDIA

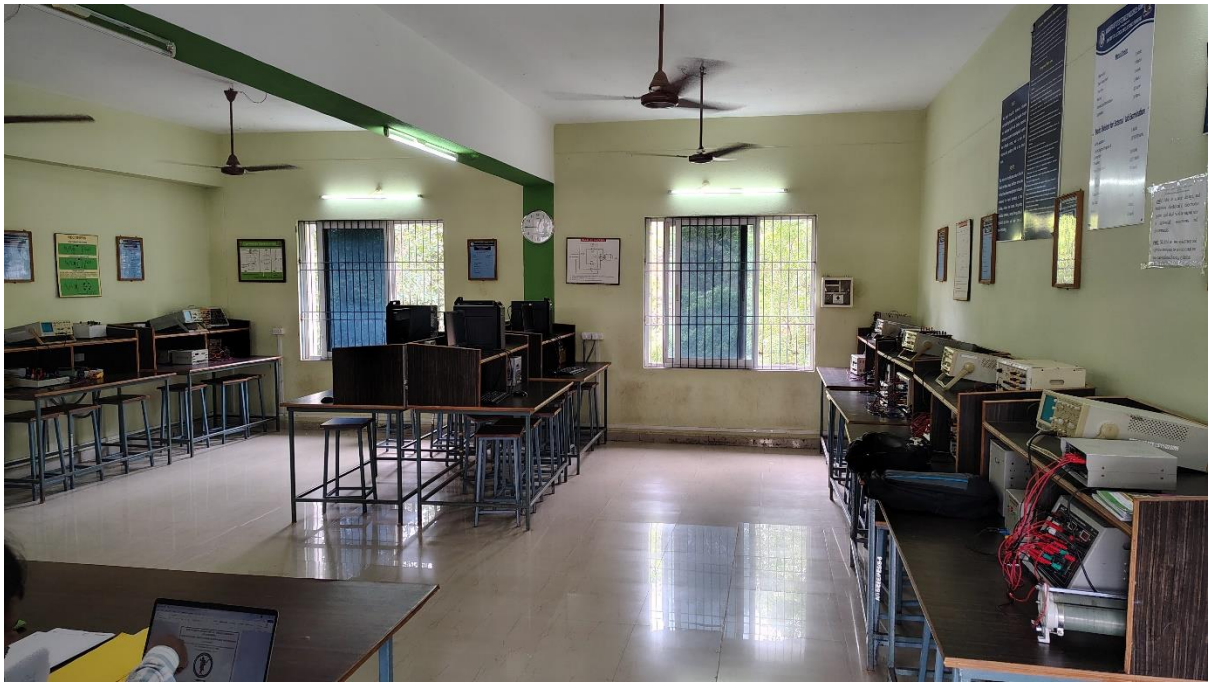
Department of Electrical and Electronics Engineering

Power Electronics and Simulation Lab

Information About Equipment

1. Lab Photo





2. Description of Control Systems Lab

The Power Electronics and Simulation Laboratory is designed to provide students with a comprehensive understanding of power semiconductor devices, converter circuits, and their applications in electrical engineering systems. The lab serves as a bridge between theoretical concepts and practical implementation, enabling students to analyze, design, and test power electronic converters that are widely used in industrial, renewable energy, and electric vehicle applications.

In this laboratory, students study the characteristics and switching behavior of semiconductor devices such as diodes, SCRs, TRIACs, MOSFETs, and IGBTs. They learn how these devices are used to control and convert electrical power efficiently through various converter topologies, including AC–DC converters (rectifiers), DC–DC converters (choppers), DC–AC converters (inverters), and AC–AC converters (cycloconverters and AC voltage controllers). The experiments focus on understanding the performance of these circuits under different load conditions, analyzing waveform shapes, and implementing control techniques like pulse-width modulation (PWM).

A major component of the lab involves simulation-based analysis using software tools such as MATLAB/Simulink, PSIM, PSpice, or LTspice. Through simulation, students can model complex converter systems, observe the effect of parameter variations, and study harmonic content and efficiency without the need for immediate hardware implementation. This simulation experience enhances their ability to design robust and efficient power electronic systems.

The lab also introduces students to closed-loop control of converters and motor drives, where feedback and control algorithms are applied to regulate voltage, current, and speed. Such skills are essential in modern applications like renewable energy integration, smart grids, electric vehicle charging systems, and power supplies.

3. Total Cost of the lab Rs. 5,83,641/-

4. Cost and quantity Information about the Equipment present in Power Electronics and Simulation Lab

S. No.	Item Description	Value (in Rs.)
1	Gate Firing Ckt of SCR Using R and RC Firing Ckts	1,530
2	Gate Firing Ckt of SCR Using UJT Firing Ckt	1,912
3	Single Phase AC Voltage Controller Unit Built in (0-48/2v) Isolator Transformer and Firing Ckt	7,225
4	Forced Commutation Study Unit With Built in Firing Ckt Class(A,B,C,D &E)	8,670
5	Single Phase Fully Controlled Bridge With Built in Meters	9,052
6	Single Phase Converter Firing Unit	2,907
7	DC Jones Chopper Power Ckt	9,640
8	DC Jones Chopper Firing Ckt	3,264
9	Single Phase Parallel Inverter Power Ckt (Centre Tap Type)With Built In Firing Ckt Rating 30V/2A : Quantity :2	10,965 23,800
10	Single Phase Cyclo Converter Power Ckt	9,843
11	Single Phase Cyclo Converter Firing Ckt	3,570
12	Three Phase Half Controlled Bridge converter With 'L' Load	14,127
13	Three Phase Converter Firing Ckt	8,823
14	Study of Characteristics of SCR,MOSFET,IGBT,DIAC & TRAIC	3,780
15	Single Phase Isolation Transformer Rating : 0,30,60,115,230V/2.5A	11,245
16	Single Phase Center Tapping Transformer Rating: 0,30,60,115,230V/2.5A	11,245
17	20 MHz Dual Trace Oscilloscope model :OS 5020	1,22,500 35,310
18	Regulated Power Supply (R.P.S)	5,700 13,000
19	Single Phase Half Controlled Converter	7,293
20	DC JONES Chopper	13335.5
21	Single Phase Cyclo Converter	10,773.75
22	Computers	15,714 35,300
23	Single phase Series Inverter	17,900 23,300
24	Single phase dual converter	28,700 19,800
	Single phase fully controlled converter with R-RL	15,283.84

25		
26	Forced commutation circuits	8,650
27	R, RC, UJT Firing circuit for SCRS	3,885
28	Single phase fully controlled bridge converter	10,800
29	C R O (8+1)	44,000
30	Edge 73 Dual Core Desktop	10,800

5. List of experiments as per syllabus

Perform any ten experiments out of the following

1. Gate Firing Circuits for SCR's (R, RC Triggering, UJT firing circuit).
2. Forced Commutation Circuits (Class A, Class B).
3. Single Phase Half Controlled Bridge Converter with R and RL loads.
4. Single Phase Fully Controlled Bridge Converter with R and RL loads.
5. Single Phase Dual Converter with RL load.
6. Single Phase Series Inverter with R and RL loads
7. Single Phase Parallel Inverter with R and RL loads.
8. Single of Phase AC Voltage Controller with R and RL Loads
9. Simulation of Single Phase Cyclo Converter with R and RL loads.
10. Simulation of Single-Phase Fully Controlled Rectifier with R, RL & RLE loads.
11. Simulation of Single-Phase Full Bridge Inverter with PWM control.
12. Simulation of Single-Phase Full Wave AC voltage controller with R&RL loads.
13. DC Jones Chopper with R and RL Loads.

6. List of experiments beyond syllabus

17. Smart Battery–Supercapacitor Hybrid Energy Storage System Using Bidirectional DC–DC Converter.
18. Grid-Connected Solar PV Inverter with MPPT and Harmonic Reduction

7. Out of Box experiments

19. Simulation of Three-Phase Fully Controlled Bridge Converter with R, RL and RLE Loads
20. Simulation of Single-Phase PWM-Based Inverter with LC Filter and Variable Frequency Control.

8. Scope of Research carried through the lab

The Power Electronics and Simulation Laboratory provides a versatile platform for both academic learning and advanced research in modern power conversion, control, and energy systems. It serves as a foundation for innovation in renewable energy integration, electric vehicles, smart grids, energy storage, and automation systems. Through a combination of experimental setups and advanced simulation tools such as MATLAB/Simulink, PSIM, and PSpice, the lab supports a wide range of research and development activities.

1. Converter Design and Optimization

The lab enables research on the design, modeling, and optimization of power electronic converters such as rectifiers, inverters, choppers, and cycloconverters. Researchers can explore advanced topologies including multilevel inverters, resonant converters, and soft-switching techniques to achieve higher efficiency, compactness, and improved power quality.

2. Control of Power Electronic Systems

Control strategies such as PWM (Pulse Width Modulation), Space Vector Modulation (SVM), PID and fuzzy logic control, and model predictive control (MPC) can be implemented and tested. These techniques are vital for precise control of converters and drives used in industrial automation, robotics, and electric transportation.

3. Renewable Energy and Microgrid Applications

The lab supports studies on solar PV systems, wind energy conversion systems, and hybrid renewable microgrids. Research includes MPPT (Maximum Power Point Tracking) algorithms, DC/DC converter optimization, DC–AC inverter control, and grid synchronization. Integration of renewable sources with battery and supercapacitor storage can be simulated to evaluate energy management strategies for microgrids.

4. Electric Vehicle (EV) and Energy Storage Systems

The lab offers facilities to research bidirectional DC–DC converters, battery management systems (BMS), supercapacitor integration, and regenerative braking control. Simulation and hardware prototypes can be developed to analyze fast-charging techniques, hybrid energy storage, and vehicle-to-grid (V2G) concepts.

5. Power Quality and Harmonic Analysis

Researchers can perform harmonic analysis, filter design, and active/reactive power compensation using advanced simulation tools. The lab allows for testing of active power filters (APF) and STATCOM models to improve voltage regulation and reduce total harmonic distortion (THD) in electrical networks.

6. Smart Grid and Automation Research

The simulation environment in the lab facilitates development of smart control algorithms for smart grids, including IoT-based monitoring, AI-assisted load forecasting, and fault detection. Power electronic interfaces used for distributed generation and demand-side management can be tested under various operating conditions.

7. Emerging Research Areas

The lab can be extended for advanced research in:

- Hydrogen-based power conversion and fuel cell systems
- Wireless power transfer (WPT) for EV charging
- Solid-state transformers (SST)
- Wide bandgap (SiC/GaN) semiconductor applications
- AI/ML-based predictive control and diagnostics of converters