INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal - 500 043, Hyderabad, Telangana

COURSE CONTENT

POWER ELECTRONICS APPLICATIONS IN POWER SYSTEMS								
I Semester: EPS								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
		L	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
BPSE03	**Core**	3	0	0	3	40	60	100
Contact Classes: 45	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 45**		
Prerequisite: Power Electronics								

I. COURSE OVERVIEW:

Students will learn how power electronics improve system stability, efficiency, and flexibility — especially in the context of renewable energy integration, smart grids, HVDC systems, and FACTS devices. This course focuses on how power electronic devices and converters are integrated into modern electrical power systems for control, conversion, and efficient utilization of electrical energy. It bridges the gap between traditional power system engineering and modern electronic control techniques.

II. COURSES OBJECTIVES:

The students will try to learn

I. Understand the principles of power electronic converters (AC-DC, DC-DC, DC-AC, AC-AC) and their operation within power systems.

II. Analyze how these converters are used for power flow control, voltage regulation, and reactive power compensation.

III. Examine FACTS (Flexible AC Transmission Systems) and HVDC technologies for modern grid operation.

IV. Explore the role of power electronics in renewable energy systems (solar, wind, energy storage integration).

V. Understand control strategies and protection techniques used in converter-based power systems.

III. COURSE OUTCOMES

The students will try to learn

CO1 Explain the fundamental principles of power electronic converters and their roles in modern power systems.

CO2 Analyze the operation, control, and performance characteristics of converters used in transmission systems such as HVDC and FACTS devices..

CO3 Evaluate the application of power electronic controllers for voltage regulation, reactive power compensation, and stability improvement in power networks.

CO4 Design and model converter-based systems for distribution networks and microgrids, including custom power devices and solid-state transformers..

CO5 Apply power electronics concepts in integrating renewable energy sources and energy storage systems with the grid while ensuring power quality and reliability.

CO6 Use simulation tools (e.g., MATLAB/Simulink) to model, analyze, and validate the performance of power electronic systems in various power system applications.

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IV. COURSE CONTENT

MODULE - I: POWER ELECTRONIC CONVERTERS (9)

Role of power electronics in power systems, Fundamentals of power converter, Voltage-Fed DC-DC Converters, Buck Boost, Buck-Boost converters, Peak Current Mode Control, Average Current-Mode Control. Control Design Issues in Voltage-Fed DC-DC Converters, Developing Switching and Average Models

MODULE - II: THREE-PHASE GRID-CONNECTED CONVERTERS (9)

High-Power Semiconductor Devices, High-Power Devices Operated as Simple Switches, PWM algorithms, Three phase voltage source inverter-Operation, Functions and Performance indices (Total Harmonic Distortion (THD), Harmonic Current Factor (HCF), Current Distortion Factor, DC Bus Capacitor within an AC/DC/AC Power Converter.

MODULE - III: LINE COMPENSATION (9)

Analysis of Uncompensated AC Line, Compensation by a Series Capacitor Connected at the Mid-point of the Line, Passive Compensation, Various FACTS devices; Power Quality Requirements, types of loads, harmonics, Active and Passive filters, Shunt, series and hybrid filters, Power Quality Conditioners,

MODULE -IV: PRINCIPLES OF CONVENTIONAL REACTIVE-POWER COMPENSATORS (9)

Concepts of SVC Voltage Control, Static Var Compensator (SVC), SVC Controller, Voltage Regulator Design, Harmonics and Filtering, Protection Aspects. Static Synchronous Compensator (STATCOM), Static Synchronous Series Compensator.

MODULE - V: UNINTERRUPTIBLE POWER SUPPLIES (9)

Power electronics in domestic and industrial loads; Power conditioning units for renewable power generation and distributed generation systems. Power Quality and Introduction to Custom Power devices.

V. Text Books:

1. Teuvo Suntio, Tuomas Messo, and Joonas Puukko, Power electronic converters: dynamics and control in conventional and renewable energy applictions, Wiley-VCH Verlag GmbH & Co. KGaA, Germany, 2018
2. A. Ghosh, G. Ledwich, Power Quality Enhancement Using Custom Power Devices, Springer, 2012.
3. Alok Jain, Power Electronics and Its Applications, Penram International Publishing (India) 2016

VI. Reference Books:

1. Dorin O. Neacsu, powers witching converters: Medium and High Power, CRC Taylor & Francis Group, LLC 2006.
2. R. Teodorescu, M. Liserre, P. Rodríguez, Grid Converters for Photovoltaic and Wind Power Systems, Wiley, 2013.
3. K. R. Padiyar, FACTS Controllers in Power Transmission and Distribution, New Age International (P) Ltd, 2007.

VII. ELECTRONICS RESOURCES:

1. https://archive.nptel.ac.in/courses/108/102/108102145/
2. https://archive.nptel.ac.in/courses/108/105/108105104/

VIII. MATERIALS ONLINE

1. Course template
2. Tutorial question bank
3. Definition and terminology
4. Tech-talk topics
5. Assignments
6. Model question paper-I
7. Model question paper-II
8. Lecture notes
9. Power point presentations