# POWER ELECTRONICS

**V Semester: EEE**

| Course Code | Category | Hours / Week | | | Credits | Maximum Marks | | |
|---|---|---|---|---|---|---|---|---|
| | | L | T | P | C | CIA | SEE | Total |
| AEE010 | Core | 3 | 1 | - | 4 | 30 | 70 | 100 |
| Contact Classes: 45 | Tutorial Classes: 15 | Practical Classes: Nil | | | | Total Classes: 60 | | |

## I. COURSE OVERVIEW:

The course focuses on presenting concepts for conversion, control and monitoring of electrical energy using power semiconductor devices. Methods for analyzing power electronic converters suitable for DC/AC, DC/DC, AC/AC and AC/DC electrical energy conversions including regulators are presented. Additionally, principles for designing power electronic converters, including their power semiconductors and passive elements are established. The applications of power electronics in the fields of sustainable energy technologies, switched mode power supplies and uninterruptible power supplies as well as application of power electronic converters for transmission, distribution and control in the power systems is described.

## II. OBJECTIVES:

**The course should enable the students to:**

- **I** The concepts on power semiconductor devices related to its characteristics, ratings, and protection to select these devices for various applications.
- **II** The fundamental principles and control techniques of power electronic converters for analyzing AC/DC, DC/DC, AC/AC and DC/AC power conversion circuits.
- **III** The application of power electronic converters in the fields of battery management system, industrial drive applications and enhancement of power quality.

## III. COURSE OBJECTIVES:

**After successful completion of the course, students should be able to:**

| | | |
|---|---|---|
| CO 1 | **Explain** the static and dynamic characteristics of power semiconductor devices used for power conversion in converter circuits. | Understand |
| CO 2 | **Summarize** the various firing circuits and commutation techniques useful for accurate switching function of the SCR. | Understand |
| CO 3 | **Analyze** the performance parameters of ac-dc converters under various loading conditions. | Analyze |
| CO 4 | **Identify** the switching techniques and control strategies in switched mode regulators and perform steady state analysis in the chopper circuit. | Apply |
| CO 5 | **Demonstrate** single phase ac voltage controllers and cyclo converter used for converting fixed ac supply into variable ac output | Understand |
| CO 6 | **Apply** modulation and switching topologies in inverters for output voltage control. | Apply |

## IV. SYLLABUS:

| UNIT - I | POWER SEMICONDUCTOR DEVICES AND COMMUTATION CIRCUITS | Classes: 09 |
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Power semiconductor devices and commutation circuits: Thyristors, principle of operation of silicon controlled rectifiers (SCR), bipolar junction transistor (BJT), power metal oxide semiconductor field effect transistor (MOSFET), power insulated gate bipolar transistor (IGBT), gate turn off thyristor (GTO) and characteristics, turn on and turnoff methods, dynamic characteristics of SCR, two transistor analogy, injunction transistor firing circuit, series and parallel operation of SCRs, design of snubber circuit; Specifications and ratings: Ratings of SCR, BJT and IGBT, line commutation and forced commutation circuits, numerical problems.

| UNIT - II | SINGLE PHASE AND THREE PHASE CONTROLLED RECTIFIERS | Classes: 10 |
|---|---|---|

AC - DC converters: Phase control technique, single phase line commutated converters, midpoint and bridge connections, half controlled converters and semi converters with R, RL and RLE loads, derivation of average load voltage and current, active and reactive power inputs to the converters without and with freewheeling diode, numerical problems; Fully controlled converters: Midpoint and bridge connections with R, RL loads and RLE load, derivation of average load voltage and current, line commutated inverters, active and reactive power inputs to the converters without and with freewheeling diode, derivation of load voltage and current, numerical problems; Three phase converters: Three pulse and six pulse converters, midpoint and bridge connections, average load voltage with R and RL loads, effect of source inductance, operation of single phase and three phase dual converters, numerical problems.

| UNIT – III | AC VOLTAGE CONTROLLERS AND CYCLOCONVERTERS | Classes: 08 |
|---|---|---|

AC - AC controllers: Introduction, single phase two SCRs in anti – parallel with R and RL loads, modes of operation of triac, triac with R and RL loads, derivation of RMS load voltage, current and power factor, wave forms, numerical problems.

Cycloconverters: Principle of operation of single phase midpoint and bridge type cycloconverters with resistive and inductive loads, continuous and discontinuous mode of operation.

| UNIT - IV | DC – DC CONVERTERS | Classes: 09 |
|---|---|---|

DC - DC converters: Principle of operation of choppers, time ratio control and current limit control strategies, types of choppers, derivation of load voltage and currents with R, RL and RLE loads, AC chopper, problems; Switched mode regulators: Study of buck, boost and buck - boost regulators, Cuk regulators.

| UNIT - V | INVERTERS | Classes: 09 |
|---|---|---|

DC - AC converters: Single phase inverter, basic series inverter, parallel inverter, operation and waveforms, voltage source inverter (VSI), three phase inverters $180^0$, $120^0$ conduction modes of operation, voltage control techniques for inverters, pulse width modulation techniques, reduction of harmonics, current source inverter (CSI) with ideal switches, capacitor commutated type CSI, numerical problems.

**Text Books:**


1. M D Singh, K B Kanchandhani, "Power Electronics", Tata McGraw-Hill Publishing Company, 2nd Edition, 1998.
2. Dr. P S Bimbhra, "Power Electronics", Khanna Publishers, 5th Edition, 2012.
3. Ned Mohan, Tore M Undeland, William P Robbins, "Power Electronics: Converters, Applications, and Design", 3rd Edition, John Wiley and sons, 2002.
4. M H Rashid, "Power Electronics, Circuits, Devices and Applications", Pearson, 3rd Edition, 2001.


**Reference Books:**


1. Vedam Subramanyam, "Power Electronics", New Age International Limited, 2nd Edition, 2006.
2. P C Sen, "Power Electronics", Tata McGraw-Hill Publishing, 1st Edition, 1987.
3. G K Dubey, S R Doradra, A Joshi, R M K Sinha, "Thyristorised Power Controllers", New Age International Limited, 2nd Edition, 2008.
4. V R Moorthi, "Power Electronics Devices", Oxford University Press, 4th Edition, 2005.


**Web References:**

1. https://www.nptel.iitm.ac.in
2. https://www.iare.ac.in
3. https://www.bookboon.com/en/introduction-to-power-electronics-ebook

**E-Text Books:**

1.https://www.freebookcentre.net
2.https://www.amazon.in/POWER-ELECTRONICS-HANDBOOK
3.https://www.circuitstoday.com

**Course Home Page:**