| 22EE450 | POWER ELECTRONICS |
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| Category | L | T | P | Credit |
|---|---|---|---|---|
| PCC | 3 | 0 | 0 | 3 |

## Preamble

Power Electronics can be defined as the application of solid state electronics for the control, conversion and transmission of electric power. Power electronic circuits convert electrical energy from one form to another form required by the load in an efficient and effective way. They find applications in industrial motor control, power supplies, vehicle propulsion systems, high voltage direct current (HVDC) systems, flexible AC transmissions (FACTs), heat controls and light controls.

## Course Outcomes

On the successful completion of the course students will be able to

| CO Number | Course Outcome Statement | TCE Proficiency Scale | Expected Proficiency in % | Expected Attainment Level % |
|---|---|---|---|---|
| CO1 | Explain steady state characteristics and applications of Power diode, Power transistor, Power MOSFET, IGBT, SCR, TRIAC, Silicon carbide devices and GaN devices. | TPS2 | 75 | 80 |
| CO2 | Design SCR triggering circuits, protection circuits and commutation circuits for the given requirements. | TPS3 | 75 | 80 |
| CO3 | Design controlled single phase and three phase rectifiers for the given specifications | TPS3 | 75 | 80 |
| CO4 | Design single phase and three phase voltage source inverters for the given specifications | TPS3 | 75 | 80 |
| CO5 | Design buck, boost and buck-boost DC-DC converters for the given specifications | TPS3 | 75 | 80 |
| CO6 | Explain the SMPS topologies, single phase and three phase AC voltage controllers. | TPS2 | 75 | 80 |
| CO7 | Analyze the performance of the given power converter and gate drive circuits using PLECS /PSPICE / MATLAB /PSIM software. | TPS4 | 75 | 80 |

## Mapping with Programme Outcomes and Programme Specific Outcomes

| Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | M | L | | | | | | M | | M | | | M | M |
| CO2 | S | M | L | | | | | M | | M | | | S | S |
| CO3 | S | M | L | | | | | M | | M | | | S | S |
| CO4 | S | M | L | | | | | M | | M | | | S | S |
| CO5 | S | M | L | | | | | M | | M | | | S | S |
| CO6 | M | L | | | | | | M | | M | | | M | M |
| CO7 | S | S | M | L | M | | | M | | M | | | S | S |

S- Strong; M-Medium; L-Low

## Assessment Pattern:

| CO | CAT 1 | | | CAT 2 | | | ASSIGNMENT 1 | | | | ASSIGNMENT 2 | | | | TERMINAL | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TPS SCALE | 1 | 2 | 3 | 1 | 2 | 3 | 3 | 4 | 5 | 6 | 3 | 4 | 5 | 6 | 1 | 2 | 3 | 4 |
| CO1 | 10 | 10 | | | | | | | | | | | | | 5 | 5 | | |
| CO2 | 5 | 15 | 20 | | | | | | | | | | | | 5 | 5 | 10 | |
| CO3 | 5 | 15 | 20 | | | | 40 | | | | | | | | | 10 | 10 | |
| CO4 | | | | 5 | 15 | 20 | 20 | | | | | | | | 5 | 5 | 10 | |
| CO5 | | | | 5 | 15 | 20 | 40 | | | | | | | | | 10 | 10 | |
| CO6 | | | | 10 | 10 | | | | | | | | | | 5 | 5 | | |
| CO7 | | | | | | | | | | | 50 | 50 | | | | | | |

**Note:** Simulation of power converters as per CO7 will be given as assignments.

## Syllabus

**Power Semiconductor Devices**

Principle of operation & static V-I Characteristics of power diode, power transistor, MOSFET, IGBT, SCR and TRIAC, merits of silicon carbide devices and GaN devices, **SCR:** Triggering circuits, protection circuits and commutation circuits.

**AC to DC Converters**

Review of uncontrolled rectifiers, Controlled Rectifiers: Half wave, half controlled, fully controlled single phase and three phase controlled rectifiers, performance parameters.

**DC to AC Converters**

Single phase and three phase voltage source inverter, frequency and voltage control, PWM schemes, harmonic distortion.

**DC-DC & AC-AC Converters**

Principle of working: Step-down, step-up, voltage commutated, current commutated chopper, switching regulators: buck, boost & buck-boost, SMPS topologies, single phase and three phase ac voltage controller.

**Applications**

Electric Drives, uninterruptible power supply, HVDC transmission, FACTS, distributed generation, custom power devices.

**Simulation of Power Converters**

Performance analysis of the power converters and gate drive circuits using PLECS /PSPICE / MATLAB /PSIM software.

## Text Book

1. Muhammad H.Rashid, Power Electronics Devices, Circuits & Applications, Fourth Edition, Pearson Education India Publication, New Delhi, 7th Impression, 2019.

## Reference Books& web resources

1. M.D.Singh & K.B.Khanchandani, Power Electronics – Tata Mc Graw Hill publishing company Ltd, New Delhi, 2008.
2. Ned Mohan, Tore Undeland & William Robbins, Power Electronics:Converters, Applications and Design-John Willey and sons, 3rd Edition, 2003.

3. P.S. Bimbhra, Power Electronics- Khanna Publishers, Sixth Edition, 2018.
4. John G.Kassakian, Martin F.Schlecht, George C.Verghese, Principles of Power Electronics, Pearson Education, 12th Impression, 2014.
5. Daniel W.Hart, Introduction to Power Electronics, First Edition, Prentice Hall International Inc.,1996.
6. L. Umanand, Power Electronics: Essentials and Applications- Wiley India, 2009.
7. Marty Brown, Power Sources and Supplies, ELSEVIER, 2008.
8. https://ocw.mit.edu/courses/electrical-engineering.

**Course Contents and Lecture Schedule**

| Module No. | Topic | No. of Hours | Course Outcome |
|---|---|---|---|
| **1.** | **Power Semiconductor Devices** | | |
| 1.1 | Principle of operation & Static V-I Characteristics: Power Diode & Power Transistor, MOSFET, IGBT | 2 | CO1 |
| 1.2 | SCR, TRIAC, Merits of Silicon carbide devices GaN devices | 2 | CO1 |
| 1.3 | Device specifications, Switching characteristics | 2 | CO1 |
| 1.4 | SCR triggering circuits, Protection circuits | 2 | CO2 |
| 1.5 | Commutation circuits | 2 | CO2 |
| **2.** | **AC to DC Converters** | | |
| 2.1 | Review of Uncontrolled Rectifiers | 1 | CO3 |
| 2.2 | Controlled Rectifier: Half-wave, Half-controlled, Fully-controlled Single phase Rectifiers | 2 | CO3 |
| 2.3 | Half-wave, Half-controlled, Fully-controlled Three phase Rectifiers | 2 | CO3 |
| 2.4 | Performance parameters of uncontrolled& Controlled Rectifiers | 2 | CO3 |
| **3.** | **DC to AC Converters** | | |
| 3.1 | Single phase Voltage source Inverters | 1 | CO4 |
| 3.2 | Three phase Voltage source Inverters | 2 | CO4 |
| 3.3 | Current source Inverters | 1 | CO4 |
| 3.4 | Frequency and Voltage Control, PWM Schemes | 2 | CO4 |
| 3.5 | Harmonic Distortion | 1 | CO4 |
| **4.** | **DC-DC & AC-AC Converters** | | |
| 4.1 | Principle of working: Step-down, Step-up, Voltage commutated, Current commutated Chopper | 2 | CO5 |
| 4.2 | Buck, Boost Switching Regulator | 2 | CO5 |
| 4.3 | Buck-Boost Switching Regulator | 1 | CO5 |
| 4.4 | SMPS Topologies | 1 | CO6 |
| 4.5 | Single phase and Three phase AC voltage controller | 2 | CO6 |
| **5.** | **Applications** | | |
| 5.1 | Electric Drives, Uninterruptible Power Supply, HVDC Transmission | 1 | CO1 |
| 5.2 | FACTS, Distributed Generation, Custom Power Devices | 1 | CO1 |
| 5.3 | Performance analysis of the power converters and gate drive circuits using PLECS /PSPICE / MATLAB /PSIM software | 2 | CO7 |
| | **Total** | 36 | |

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