

**BTETPE604C**

**Power Electronics**

**3 Credits**

**Course Objectives:**

- To introduce students to different power devices to study their construction, characteristics and turning on circuits.
- To give an exposure to students of working & analysis of controlled rectifiers for different loads, inverters, DC choppers, AC voltage controllers and resonant converters.
- To study the different motor drives, various power electronics applications like UPS, SMPS, etc. and some protection circuits.

**Course Outcomes:**

At the end of this course students will demonstrate the ability to

1. Build and test circuits using power devices such as SCR
2. Analyze and design controlled rectifier, DC to DC converters, DC to AC inverters,
3. Learn how to analyze these inverters and some basic applications.
4. Design SMPS.

**UNIT - 1**

**Characteristics of Semiconductor Power Devices**

Thyristor, power MOSFET and IGBT- Treatment should consist of structure, Characteristics, operation, ratings, protections and thermal considerations. Brief introduction to power devices viz. TRIAC, MOS controlled thyristor (MCT), Power Integrated Circuit (PIC) (Smart Power), Triggering/Driver, commutation and snubber circuits for thyristor, power MOSFETs and IGBTs (discrete and IC based). Concept of fast recovery and schottky diodes as freewheeling and feedback diode.

**UNIT - 2**

**Controlled Rectifiers**

Single phase: Study of semi and full bridge converters for R, RL, RLE and level loads. Analysis of load voltage and input current- Derivations of load form factor and ripple factor, Effect of source impedance, Input current Fourier series analysis of input current to derive input supply power factor, displacement factor and harmonic factor.

**UNIT - 3**

**Choppers**

Quadrant operations of Type A, Type B, Type C, Type D and type E choppers, Control techniques for choppers – TRC and CLC, Detailed analysis of Type A chopper. Step up chopper. Multiphase Chopper.

**UNIT - 4**

**Single-phase inverters**

Principle of operation of full bridge square wave, quasi-square wave, PWM inverters and comparison of their performance. Driver circuits for above inverters and mathematical analysis of output (Fourier series) voltage and harmonic control at output of inverter (Fourier analysis of output voltage). Filters at the output of inverters, Single phase current source inverter.

**UNIT - 5**

**Switching Power Supplies**

Analysis of fly back, forward converters for SMPS, Resonant converters - need, concept of soft switching, switching trajectory and SOAR, Load resonant converter - series loaded half bridge DC-DC converter.

**UNIT - 6**

**Applications**

Power line disturbances, EMI/EMC, power conditioners. Block diagram and configuration of UPS, salient features of UPS, selection of battery and charger ratings, sizing of UPS, Separately excited DC motor drive. P M Stepper motor Drive

**TEXT/REFERENCE BOOKS**

1. Muhammad H. Rashid, "Power electronics" Prentice Hall of India.
2. Ned Mohan, Robbins, "Power electronics", edition III, John Wiley and sons.

UNIT 1

1. Explain two transistor analogy of an SCR and derive an expression for anode current in terms of transistor parameter?
2. Describe the following ratings as applicable to SCR.
  - i. Surge current rating.
  - ii.  $(i)^2 t$  rating.
  - iii.  $di/dt$  rating.
  - iv.  $dv/dt$  rating.
3. Draw vertical section and V-I characteristics of IGBT.
4. Write a short note on snubber circuit.
5. Write a short note on Repetitive and non-repetitive rating of SCR.
6. Write a short note on Fast recovery and Schottky diodes.
7. Draw vertical structure of power MOSFET. Explain its operation.
8. What are power devices? Explain with V-I characteristics of SCR.
9. Draw and explain driver circuits for IGBT.
10. Write a short note on modes of operation of TRIAC.

UNIT 2

11. With the help of circuit diagram and wave forms explain working of single phase half wave converter with resistive load.
12. With the help of circuit diagram and wave forms explain working of single phase half wave converter with resistive (R) load.
13. With the help of circuit diagram and wave forms explain working of single phase half wave converter with RL load.
14. With the help of circuit diagram and wave forms explain working of single phase half wave converter with RL load and free-wheeling diode.
15. With the help of circuit diagram and wave forms explain working of single phase full wave converter with resistive R load.
16. With the help of circuit diagram and wave forms explain working of single phase half controlled bridge rectifier with resistive R load.
17. With the help of circuit diagram and wave forms explain working of single phase half controlled bridge rectifier with RL load.
18. A single phase full controlled converter is fed from 230v, 50 Hz supply. The load is highly inductive find the average load voltage and current if the load resistance is 10 ohm and firing angle is  $45^\circ$ .

19. A single phase semi converter is operated from 230V, 50 Hz AC supply. The load is resistive having resistance of 10 ohm and firing angle is  $60^\circ$  calculate.
- Average output voltage.
  - RMS output voltage.
20. A single phase fully controlled bridge operates with 230V , 50 Hz AC input and supplies continuous ripple free output current of 5 A. if bridge is operated at a firing angle of  $45^\circ$  find:
- Average output voltage.
  - RMS supply current.

### UNIT 3

- Explain with circuit diagram operation of set-up chopper.
- Explain with circuit diagram operation of set-down chopper.
- Explain operation of set-down chopper. Derive an expression for its output voltage.
- Explain the operation of four quadrants chopper with circuit diagram and waveforms.
- What are control strategies? Explain how to control the output voltage of chopper.
- What is chopper? Explain in brief.
- Explain the operation of Type A chopper.
- Explain the operation of Type A or Type C chopper with circuit diagram and waveforms.
- Explain the operation of Type B or Type D chopper with circuit diagram and waveforms.
- A DC chopper has a resistive load of 20 ohm and input voltage  $V_s = 200$  V. When chopper is ON, its voltage drop is 1.5 volts and chopping frequency is 10 kHz. If the duty cycle is 80% determine the average output voltage.

### UNIT 4

- Explain the principle of operation of an inverter.
- Explain the operation of single phase bridge inverter.
- Explain the operation of single phase bridge inverter with R L load.
- What are the different pulse width modulation techniques used for inverters. Explain any one.
- Single phase full bridge inverter is operated from 48V dc supply, it has resistive load of 2.4 ohm. Find its RMS output voltage at fundamental frequency.
- Explain the various parameter performance of an inverter.
- Write a short note on PWM inverters.
- Write a note on voltage control and harmonic reduction in voltage source inverter.
- Compare VSI and CSI.

**UNIT 5**

1. Explain the operation of SMPS.
2. What is need of resonant converter? Explain Zero Current Switching resonant converter with circuit diagram and waveforms.
3. Explain SLR half bridge dc-dc converter.
4. Explain Zero Voltage Switching resonant converter with circuit diagram and waveforms.
5. Write a short note soft switching.
6. Explain classification of resonant converter.
7. Explain flyback converter.
8. Write a short note on over voltage protection in power.
9. Explain the concept of forward converter for SMPS.

**UNIT 6**

1. What is EMI? What are different sources of EMI.
2. With the help of block diagram, explain On-Line UPS system.
3. Draw the block diagram of on Off-Line UPS and explain the function of each block.
4. What is the need of UPS? Explain the UPS system and its component.
5. Write short note on Separately excited DC motor drive.
6. Explain concept of EMI minimizing Techniques.
7. Explain the concept of battery charger rating.
8. Give the definition of the following:
  - (i) Battery capacity.
  - (ii) Back-up time.
  - (iii) Charger peak power.

Subject Teacher: Mr. Tejas Umesh Mahagaonkar.  
Assistant Professor (Ad-hoc)  
Department of Electronics and Telecommunication Engineering.  
Dr. Babasaheb Ambedkar Technological University, Lonere  
Email-id: [tumahagaonkar@dbatu.ac.in](mailto:tumahagaonkar@dbatu.ac.in)