

# POWER ELECTRONICS

## QUESTION BANK

### UNIT-1 POWER SEMICONDUCTOR DEVICES

#### PART-A

1. State the advantage IGBT over MOSFET.
2. What is function of snubber circuit?
3. What is latching current of SCR?
4. In TRICACs which of the modes the Sensitivity of the gate is high.
5. Why are IGBT becoming popular in their application to controlled converters?
6. What are the factors that influence the turn-off time of the thyristor?
7. Define the softness factor of a power diode.
8. Draw the V-I characteristics of SCR and mark the holding current and latching current in the characteristics.
9. What are the advantages of GTO over BJT?
10. Define holding current of SCR.
11. Define string efficiency of SCRs connected in series.
12. What is the fast recovery diode? Mention its uses.
13. Distinguish between holding current and latching current of SCR.
14. Why is pulse triggering preferred over RC triggering?
15. What is reverse recovery time?
16. Mention two advantages of GTO over SCR.
17. What are the factors that influence the reverse recovery current of a power diode?
18. Why MOSFETs are not preferred for low frequency application?
19. Why are IGBT becoming popular in their application to controlled converters?
20. Draw the turn-on characteristics of SCR and mark the timings  $t_d$ ,  $t_r$  and  $t_{on}$ .
21. Define the term pinch-off voltage of MOSFET.
22. Mention any two merits and demerits of SCR.
23. Mention any two application of SCR.
24. Define the following:
25. (a)turn-on time (b)turn-off time (c)converter grade SCR (d)inverter grade SCR
26. What are requirements of gate drive? What is pulse gate drive?
27. Compare BJT, MOSFET and IGBT.
28. How DIAC can be used to trigger TRIAC?

#### PART-B

1. Explain the various types of triggering methods of SCR.
2. Why gate drive is used as universally used method? Why?
3. Explain the switching characteristics of MOSFET.
4. How does the concept of saturation differ in MOSFET with BJT.
5. Describe the construction of TRIAC and explain its four different modes of Operation with diagrams and characteristics.
6. Explain the constructional details of an SCR.
7. Based on two analogy, explain the turn-on mechanism of an SCR. also derive an expression for the anode current.
8. Explain the working of RC triggering circuit of the SCR.
9. Explain the transient model of BJT.
10. Discuss the different modes of thyristor with the help of its static V-I characteristics of power MOSFET.
11. Draw the structure of IGBT and explain its operation.
12. Draw and explain the forward characteristics of SCR using two transistor model of SCR.
13. Compare any six salient features of MOSFET and IGBT.

14. Explain the turn off characteristics of SCR.
15. Describe any one MOSFET gate drive circuit in detail.
16. Discuss the transfer ,output and switching characteristics of power MOSFET.
17. Explain the switching performance of BJT with relevant waveforms indicating clearly the turn on, turn off times and their components. Also define the term SOA.
18. Explain why TRIAC is rarely operated in First quadrant with -ve gate current and in third quadrant with +ve gate current.

## UNIT-2 PHASE CONTROLLED CONVERTERS

### PART-A

1. Define the delay angle of phase controlled rectifier
2. What are two types of ac voltage controlled? Which one of these is preferred and why?
3. A1 phase half wave rectifier is used to supply power to load impedance of 10 ohm from 230V , 50Hz AC supply at the firing angle 30 degree calculate the load current.
4. What is full converter ? what is dual converter?
5. What is function of free wheeling diode in semiconductor ?
6. List the merits demerits of ac voltage controller?
7. Write the output voltage relation of single phase full converter . Also draw its various with firing angle.
8. Draw the typical current and voltage waveforms of single phase full converter with source inductor?
9. Compare on-off and phase-angle Ac voltage controllers?
10. What are effects of load inductance on the performance of Ac voltage controllers?
11. Define harmonic factor of the input current
12. What is freewheeling diode ,and what is its purpose?
13. What is effect of inductive load in the performance of three phase bridge rectifier?
14. What are parameters that evaluated in rectifiers?
15. List the various application of phase controlled converter.
16. What is Ac voltage controller.
17. Define the terms : displacement factor ,total harmonic distortion
18. State the principle of phase control in AC-DC converters
19. When a fully controlled converter operates in inverting mode?
20. Under what condition a single phase fully controlled converter gets operates as an inverter?
21. Define the term duty cycle of DC choppers?
22. It is required to operate a 1 phase converter in the inverter mode with RLE load should average output voltage be more or less than E during inverter operation? why?
23. Why is power factor of semi converter better than full converter
24. What is the inversion mode of rectifier
25. Write the expression for output dc voltage in a single phase fully controlled converter.

### PART-B

1. Describe the working of single phase fully controlled bridge converter in rectifier mode and inversion mode. Sketch the waveform of delay angle alpha ,load voltage, load current and thyristor voltage.
2. Explain the operation of 3phase 6 pulse bridge converter with resistive load. Draw the output voltage and current waveform of T1 for alpha=0 degree list the firing sequence of SCRs.
3. For a single phase controller, feeding a resistive load, Draw the waveforms of source voltage gating signal output voltage across the SCRS. Describe the working with reference to waveform drawn.
4. Explain the operation of single phase semi converter and derive expression of its average and RMS output voltage
5. Derive the expression for harmonic factor, displacement factor and power factor of a single phase fully converter from the fundamental principle.
6. A single phase voltage feeds power to a resistive load 3ohm from 230v 50HZ source calculate
  - the maximum values of average and thyristor currents for any firing angle alpha

- the minimum circuit turn off time for any firing angle  $\alpha$
  - the ratio of third harmonic voltage to fundamental voltage  $\alpha=60^\circ$
7. Describe the operation of single phase full wave controlled rectifier feeding of R-L load . what is the effect of adding a freewheeling diode on the performance of the converter ?
  8. A single phase full converter is supplied from 230v 50HZ source the load consist of  $R=10\Omega$  and a large inductance so as to render the load current constant for a firing angle delay of  $30^\circ$ , determine
    - 1)average output voltage
    - 2)average output current
    - 3)average and rms values of thyristor current
    - 4)the power factor
  9. Bring out the merits and demerits of using AC voltage controllers for induction motor and speed control
  10. A single phase full wave controller feeds power to a resistive load of  $100\Omega$  230v,50HZ supply. Calculate the rms output voltage input power factor and the half cycle average current at delay angles  $\alpha_1=\alpha_2=\alpha=\pi/2$  of both thyristors.
  11. For a single phase full converter ,load current can be continuous and its ripple content is negligible .the turns ratio of the transformer is unity
    - 1)Express the input current in a Fourier series
    - 2) Determine the harmonic factor of input current and input power factor
  12. With aid of circuit diagram and waveform explain the operation of
    - 1)single phase unidirectional controller
    - 2)single phase bidirectional controller
  13. Explain the operation of single phase controller with inductive load
  14. Explain using a diagram the operation of the three phase full converter
  15. A single phase bridge converter is supplied from a star connected 208v,50HZ supply the average load current is 60A and has negligible ripple . calculate the percentage reduction of output voltage due of commutation if the line inductance for phase is 0.5mH
  16. Describe the operation of a 1 phase two pulse bridge converter using 4 SCRs with relevant waveforms.
  17. Discuss the working of above converter in inverter mode with RLE load.
  18. Draw the possible configuration of a single phase AC voltage controller and compare them.
  19. Derive the expression for average output voltage of single phase semi converter.
  20. With necessary circuit and waveforms explain the principle of operation of three phase fully controller bridge rectifier feeding R-L load and derive expression for the average output voltage.
  21. With necessary circuit and waveforms , explain the principle of operation of single phase ac voltage controller having only thyristors feeding resistive load by on-off control and phase control. Derive the expression for rms value of output voltage in both cases.
  22. A two pulse single phase bridge converter is connected to RLE load. Source voltage 230, 50HZ .average load current of 10 amps is continuous over the working range . for  $R=0.4\Omega$  and  $L=2\text{mH}$  compute.
    - 1)firing angle delay for  $E=120\text{v}$
    - 2)firing angle delay for  $E=-120\text{v}$
  23. Discuss the operation of single phase half controlled rectifier with inductive load. Also derive average output voltage equation.
  24. Explain the operation of three phase half controlled rectifier supplying R load with neat waveforms .Also derive an expression for the average output voltage.

### UNIT-3 DC-DC CONVERTERS

#### PART-A

1. What are the control strategies of chopper?
2. Mention the disadvantage of FM scheme used in chopper?
3. What are methods of controlling the output voltage of a chopper?

4. What are advantage and disadvantage of buck/boost regulator ?
5. Define the term duty cycle of DC choppers?
6. Differentiate between constant frequency and variable frequency control strategies of varying the duty cycle of DC choppers
7. What is meant by time ratio control in dc-dc converter?
8. What are classification of dc to dc converter depending upon the direction of current and voltage ?
9. What is meant by buck regulator?
10. Define the term duty cycle in dc-dc converter?
11. What is meant by pulse width modulation control in dc choppers/
12. What is two quadrant Dc chopper?
13. Write any two salient features of CUK converter?

#### **PART-B**

1. Describe the principle of step –up chopper. derive an expression for the output voltage in terms of input dc voltage and duty cycle . state the assumption made.
2. A step-up chopper supplies a load of 480v from 230v dc supply Assuming the non conduction period of thyristor to be 50 micro sec, find on time of the thyristor.
3. For a type A chopper (first quadrant), express the following variables as a function of  $V_s$  R and duty cycle  $\delta$  in case the load is resistive .
  - Average output voltage
  - current
4. With the help of power circuit diagram ,discuss the operation of class c and class d types of two quadrant choppers
5. In a type A chopper, the input supply voltage is 230v the load resistance is 10 ohm and there is a voltage of 2V across the chopping thyristor when it is on. For a duty ratio of 0.4 , calculate the average and rms values of the output voltage .Also find the chopper efficiency
6. Draw the circuit diagram of a buck converter and explain it operation with equivalent circuit for different modes and waveforms.
7. Design the filter components for a buck converter which has an input voltage of 12v and output voltage of 5v the peak to peak voltage is 20mV and peak to peak ripple current of inductor is limited to 0.8A. The switching frequency is 25KHZ.
8. Discuss the principle of operation of DC-DC step down chopper with suitable waveforms. Derive an expression for its average DC output voltage.
9. A step down dc chopper has input voltage of 230v with 10ohm load resistor connected voltage drop across chopper is 2v when it is on. for a duty cycle of 0.5 calculate:
  - Average and rms value of output voltage
  - power delivered to the load.
10. Discuss the need for resonant switching in SMPS.
11. Describe briefly the principle of operation of buck-boost converter with a neat diagram .
12. Draw the circuit of cuk regulator and explain its working principle with necessary waveform in detail.
13. A step up chopper has voltage of 220V and output of 660V. If the non conducting time of thyristor chopper is 100 micro sec compute the pulse width of output voltage . in case of pulse width is halved for constant frequency operation find the new output voltage.
14. Classify the basic topologies of switching regulator s and explain the operation the buck regulator with continuous load current using suitable waveform.
15. With necessary circuit and waveform , explain the principle of operation of step down DC-DC converter with RL load.

## UNIT-4 - INVERTERS

### PART- A

1. List the four applications of CSI.
2. Distinguish between VSI and CSI.
3. A single phase full bridge inverter has a resistive load of  $R= 10\Omega$  and the input voltage  $V_{dc}$  of 100 volt. Find the RMS output voltage at fundamental frequency.
4. What is PWM? List out its various techniques.
5. What are the main difference between current driven and voltage driven inverters.
6. Define modulation index of PWM. What is its use?
7. List a few industrial applications of inverters.
8. What is the purpose of connecting diode in anti-parallel with thyristors in inverters?
9. What is the need for voltage control in an inverter?
10. What are the modulation techniques used in inverters?
11. Define modulation index in pulse width modulation employed in an inverter?
12. Mention any two advantages of current source inverter.
13. Define the term inverter gain.
14. Mention the difference between sinusoidal PWM and modified sinusoidal PWM techniques.
15. Mention the various performance parameters used for inverter.
16. Write short notes on modified sinusoidal PWM.
17. Write short notes on feedback operation in inverter.
18. Write short notes on harmonic distortion in inverter.
19. State any two advantages and disadvantages of series inverter.
20. What are the applications of CSI.

### PART- B

1. Describe the operation of series inverter. What are its advantages?
2. State different methods of voltage control in inverters. Describe about PWM control in inverter.
3. Explain the principle of operation of single phase half bridge inverter.
4. The single phase half bridge inverter has a resistive load of  $2.4\Omega$  and the dc input voltage of 48V. Determine the RMS output voltage at the fundamental frequency, output power and total harmonic distortion.
5. Describe with a neat sketch and waveforms the operation of a single phase half bridge inverter supplying RL load.
6. Discuss the applications of PWM techniques in the inverter, Bring out its uses.
7. With the neat diagram and waveforms, explain 3-phase voltage source inverter, using transistors operating in  $180^\circ$  conduction mode. Also obtain the expression for RMS value of output voltage.
8. With aid of circuit diagram and relevant waveforms, explain the operation of PWM inverters.
9. Explain the operation of a single phase capacitor commutated CSI with R load with equivalent circuit and output waveforms.
10. Explain using a diagram the operation of a series inverter. Bring out its limitations. Develop the circuit of a modified series inverter with a neat diagram explain the single pulse width modulation method of voltage control of inverters.
11. Describe the working of a single phase full bridge inverter with relevant circuit and waveforms.
12. What is PWM? List the various PWM techniques and explain any one of them.
13. Discuss the working of single phase series resonant inverter with appropriate circuit and waveforms.
14. With a neat circuit and relevant waveforms discuss the operation of an ideal single phase CSI.

15. Explain the following PWM techniques used in an inverter.
  - (i) Sinusoidal PWM.
  - (ii) Multiple PWM.
16. Describe the working of a single phase full bridge inverter supplying R, RL loads with relevant circuit and waveforms.

## **UNIT- 5 APPLICATIONS**

### **PART- A**

1. Name the various configurations of UPS.
2. State the merits of HVDC transmission.
3. What is principle role of FACTS.
4. What is Static VAR Compensator.
5. Mention the different types of HVDC link.
6. List the parameters for controlling power in a transmission line.
7. What is off-line UPS?
8. Name any two types of FACTS devices.
9. Compare offline and online UPS.
10. How battery is selected for the UPS system?
11. State the advantages and disadvantages of online UPS over offline UPS.
12. Compare HVAC and HVDC transmission.

### **PART- B**

1. What is an UPS? Describe the no-break static UPS configuration with block diagram.
2. Write technical notes on HVDC transmission.
3. Write short note on Static VAR Compensator.
4. With neat block diagrams, explain the working principle of online and offline UPS.
5. Draw the circuit of UPS system in which a single circuit operates as rectifier to charge the battery when the main supply is available and the same circuit act as a inverter when the main supply is not available.
6. Write short notes on: shunt Static VAR Compensator and unified power flow controller.
7. Describe the principle of operation of no-break static UPS configuration with a neat block diagram and list out its applications.
8. Explain the principle of operation of unified power flow controller as a compensator with neat circuit arrangement.