



SNS COLLEGE OF TECHNOLOGY

(An Autonomous Institution)
COIMBATORE-35



DEPARTMENT OF EEE

TWO MARK QUESTION & ANSWERS

COURSE: 19EET301 / POWER ELECTRONICS AND DRIVES

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UNIT – I: Power Semiconductor Devices

1. What is Power Electronics?

Power electronics is a subject that concerns the applications electronics principles into situations that are rated at power level rather than signal level. It may be defined as a subject deals with the apparatus and equipment working on the principle of electronics but at rated power level.

2. Give the applications of power electronics.

Aerospace
Commercial
Industrial
Telecommunications

3. Classify power semiconductor devices give examples.

- Diodes: Power diodes
- Thyristors: SCR
- Control switches: BJT, MOSFET and IGBT

4. What are the types of power transistors?

Bipolar Junction Transistor (BJT)
Metal Oxide Semiconductor Field Effect Transistor (MOSFET)
Insulated Gate Bipolar Transistor (IGBT)

5. Why IGBT is very popular nowadays?

- a. Lower gate requirements
- b. Lower switching losses
- c. Smaller snubber circuit requirements

6. What are the different methods to turn on the thyristor?

- a. Forward voltage triggering
- b. Gate triggering
- c. dv/dt triggering
- d. Temperature triggering
- e. Light triggering

7. What is the difference between power diode and signal diode?

S.No.	Power diode	Signal diode
1.	Constructed with n-layer, called drift region between p+ layer and n+ layer.	Drift region is not present.
2.	The voltage, current and power ratings are higher.	Lower
3.	Power diodes operate at high speeds.	Operates at higher switching speed.

8. IGBT is a voltage-controlled device. Why?

Because the controlling parameter is gate-emitter voltage.

9. Power MOSFET is a voltage-controlled device. Why?

Because the output (drain) current can be controlled by gate-source voltage.

10. Power BJT is a current controlled device. Why?

Because the output (collector) current can be controlled by base current.

11. What is the relation between α and β ?

$$\beta = \frac{\alpha}{1 - \alpha}$$

$$\alpha = \frac{\beta}{1 + \beta}$$

12. What are the different types of power MOSFET?

- a. N-channel MOSFET
- b. P-channel MOSFET

13. How can a thyristor be turned off?

A thyristor can be turned off by making the current flowing through it to a level below the holding current.

14. Define latching current.

The latching current is defined as the minimum value of anode current which it must attain during turn on process to maintain conduction when gate signal is removed.

15. Define holding current.

The holding current is defined as the minimum value of anode current below which it must fall to for turning off the thyristor.

16. What is a snubber circuit?

It consists of a series combination of a resistor and a capacitor in parallel with the thyristors. It is mainly used for dv / dt protection.

17. What losses occur in a thyristor during working conditions?

- a. Forward conduction losses
- b. Loss due to leakage current during forward and reverse blocking.
- c. Switching losses at turn-on and turn-off.
- d. Gate triggering loss.

18. Define hard-driving or over-driving.

When gate current is several times higher than the minimum gate current required, a thyristor is said to be hard-fired or over-driven. Hard-firing of a thyristor reduces its turn-on time and enhances its di/dt capability.

19. Define circuit turn off time.

It is defined as the time during which a reverse voltage is applied across the thyristor during its commutation process.

20. Why circuit turn off time should be greater than the thyristor turn-off time?

Circuit turn off time should be greater than the thyristor turn-off

time for reliable turn-off, otherwise the device may turn-on at an undesired instant, a process called commutation failure.

21. What is meant by commutation?

It is the process of changing the direction of current flow in a particular path of the circuit. This process is used in thyristors for turning it off.

22. What are the types of commutation?

- a. Natural commutation
- b. Forced commutation

23. What is the turn-off time for converter grade SCRs and inverter grade SCRs?

Turn-off time for converter grade SCRs is 50 – 100 ms turn-off time for converter grade SCRs and inverter grade SCRs and for inverter grade SCRs is 3 – 50 ms.

24. What are the advantages of GTO over SCR?

- a. Elimination of commutation of commutating components in forced commutation, resulting in reduction in cost, weight and volume.
- b. Reduction in acoustic noise and electromagnetic noise due to elimination of commutation chokes.
- c. Faster turn-off, permitting high switching frequencies.
Improved efficiency of the converters.

25. Write down the applications of IGBT?

They are widely used for medium power applications.

- AC and DC motor drives
- UPS systems
- Power supplies
- Relays and Contactors

26. Compare Power MOSFET with BJT.

Power MOSFET	BJT
1. Lower Switching loss	Higher switching loss
2. high on state resistance so more conduction losses	lower conduction losses
3. Voltage controlled device	Current controlled device
4. It has positive temperature coefficient	It has negative temperature coefficient

27. Why IGBT is very popular now a days?

- Lower gate drive requirement
- Lower switching losses
- Smaller snubber circuit requirements

28. What are the different methods to turn on the thyristor?

Forward voltage triggering, Gate triggering, dv/dt triggering, temperature triggering & light triggering

29. Define forward breakover voltage .

When anode is positive w.r.to cathode with gate current open, the junction J1 & J3 are forward biased but J2 is reverse biased. When the forward voltage is increased junction J2 will have an avalanche breakdown at a voltage. This voltage is called forward breakover voltage.

30. Define reverse breakover voltage .

When cathode is positive w.r.to anode with gate current open, the junction J1 & J3 are reverse biased but J2 is forward biased. When the reverse voltage is increased junctions J1 & J3 will have an avalanche breakdown at a voltage. This voltage is called as critical breakdown voltage V_{br} .

31.IGBT is a voltage controlled device. Why?

IGBT is a voltage controlled device because the controlling parameter is gate emitter voltage V_{GE}

32.Power MOSFET is a voltage controlled device. Why?

Power MOSFET is a voltage controlled device because the output current can controlled by gate source voltage V_{GS} .

UNIT – II – Phase Controlled Converters

1. What is meant by phase controlled rectifier?

It converts fixed ac voltage into variable dc voltage.

2. Mention some of the applications of controlled rectifier.

- f. Steel rolling mills, printing press, textile mills and paper mills employing dc motor drives.
- g. DC traction
- h. Electro chemical and electro-metallurgical process
- i. Portable hand tool drives
- j. Magnet power supplies
- k. HVDC

3. What is the function of freewheeling diodes in controlled rectifier?

It serves two process.

- l. It prevents the output voltage from becoming negative.
- m. The load current is transferred from the main thyristors to the freewheeling diode, thereby allowing all of its thyristors to regain their blocking states.

4. What are the advantages of freewheeling diodes in a controlled rectifier?

- n. Input power factor is improved.
- o. Load current waveform is improved and thus the load performance is better.

5. What is meant by delay angle?

The delay angle is defined as the angle between the zero crossing of the input voltage and the instant the thyristor is fired.

6. What are the advantages of single phase bridge converter over single phase mid-point converter?

1. SCRs are subjected to a peak-inverse voltage of $2V_m$ in a fully controlled bridge rectifier. Hence for same voltage and current ratings of SCRs, power handled by mid-point configuration is about
2. In mid-point converter, each secondary winding should be able to supply the load power. As such, the transformer rating in mid-point converter is double the load rating.

7. What is commutation angle or overlap angle?

The commutation period when outgoing and incoming thyristors are conducting is known as overlap period. The angular period, when both devices share conduction is known as the commutation angle or overlap angle.

8. What are the different methods of firing circuits for line commutated converter?

1. UJT firing circuit.
2. The cosine wave crossing pulse timing control.
3. Digital firing schemes.

9. Give an expression for average voltage of single-phase semiconverters.

Average output voltage $V_{dc} = (V_m / \pi) (1 + \cos \alpha)$.

10. What is meant by input power factor in controlled rectifier?

The input power factor is defined as the ratio of the total mean input power to the total RMS input volt-amperes.

$PF = (V_1 I_1 \cos \phi_1) / (V_{rms} I_{rms})$ where V_1 = phase voltage, I_1 = fundamental component of the supply current, ϕ_1 = input displacement angle, I_{rms} = supply rms current.

11. What are the advantages of six-pulse converter?

1. Commutation is made simple.
2. Distortion on the ac side is reduced due to the reduction in lower order harmonics.
3. Inductance reduced in series is considerably reduced.

12. What is the difference between ON-OFF control and phase control?

ON-OFF control: In this method, the thyristors are employed as switches to connect the load circuit to the source for a few cycles of the load voltage and disconnect it for another few cycles.

Phase control: In this method, thyristor switches connect the load to the ac source for a portion of each half cycle of input voltage.

13. What is the disadvantage of ON-OFF control?

This type of control is applicable in systems that have high mechanical inertia and high thermal time constant.

14. What is the duty cycle in ON-OFF control method?

Duty cycle $K = n / (n + m)$,
where n = no. of ON cycles, m = no. of OFF cycles.

15. What is mean by uncontrolled rectifier?

The uncontrolled rectifier uses only diodes and it converts fixed ac voltage into fixed dc voltage.

16. How to classify rectifier circuits.

- (i) Uncontrolled rectifier
- (ii) Controlled rectifier

17. What is mean by full converter?

A fully controlled converter uses thyristors only and there is a wider control over the level of dc output voltage. It is also known as two quadrant converter.

18. What is meant by 2 pulse converter?

Two pulse converter is defined as two triggering pulses or two sets of triggering pulses are to be generated during every cycle of the supply to trigger the various SCRs.

19. What is meant by rectification mode in single phase fully controlled converter?

In single phase full converter $< 90^\circ$ the voltage at the dc terminal is positive. Therefore, power flows from source to load & the converter operates as a rectifier. Source voltage is V_s & Current is positive. This is known as rectification mode.

20. What is meant by inversion mode?

In single phase full converter $> 90^\circ$ the voltage at the dc terminal is negative. Therefore, power flows from load to source & the converter operates as line commutated inverter. Source voltage V_s is negative & Current is positive. This is known as inversion mode or synchronous mode.

21. What are the different types of controlled rectifier?

According to input supply – Single phase controlled rectifier & Three phase controlled rectifier

According to Quadrant operation – semiconverter , full converter, dual converter

According to no. pulses / cycle – one pulse, two pulse, three pulse , Six pulse & twelve pulse converter.

22. What are the difference between half controlled & fully controlled bridge rectifier?

Half Controlled Bridge Rectifier

1. Power circuit consists of mixture of diodes & SCRs
2. It is one quadrant Converter
3. The Dc output voltage has limited control level.
4. Input power factor is more.

Full Controlled Bridge Rectifier

1. Power circuit consists of SCRs only
2. It is 2 quadrant Converter
3. The Dc output voltage has wider control level.
4. Input power factor is less.

23. What is meant continuous current operation of thyristor converter?

When a free- wheeling diode is connected across the output, load current continuous flow through the load. Whenever the load voltage tends to go to negative, free- wheeling diode starts conduct. As a result load current is transferred from SCR to freewheeling diode. This is called continuous current operation is thyristor converter.

24. What is meant by commutation?

It is the process of changing the direction of current flow in a particular path of the circuit. This process is used in thyristors for turning it off.

25. What are the types of commutation?

- ll. Natural commutation
- mm. Forced commutation

26. What is meant by natural commutation?

Here the current flowing through the thyristor goes through a natural zero and enable the thyristor to turn off.

27. What is meant by forced commutation?

In this commutation, the current flowing through the thyristor is forced to become zero by external circuitry.

28. What is meant by dc chopper?

A dc chopper is a high speed static switch used to obtain variable dc voltage from a constant dc voltage.

29. What are the applications of dc chopper?

1. Battery operated vehicles
2. Traction motor control in electric traction
3. Trolley cars
4. Marine hoists
5. Minehaulers
6. Electric braking.

30. What are the advantages of dc chopper?

Chopper provides

1. High efficiency
2. Smooth acceleration
3. Fast dynamic response
4. Regeneration

31. What is meant by step-up and step-down chopper?

In a step-down chopper or Buck converter, the average output voltage is less than the input voltage. In a step-up chopper or Boost converter, the average output voltage is more than the input voltage.

32. Write down the expression for average output voltage for step down chopper.

Average output voltage for step down chopper $V_0 = \alpha V_s$, α is the duty cycle

33. Write down the expression for average output voltage for step up chopper.

Average output voltage for step up chopper $V_0 = \frac{V_s}{1 - \alpha}$, α is the duty cycle

34. What is meant by duty-cycle?

Duty cycle is defined as the ratio of the on time of the chopper to the total time period of the chopper. It is denoted by α .

35. What are the two types of control strategies?

- xx. Time Ratio Control (TRC)
- yy. Current Limit Control method (CLC)

36. What is meant by TRC?

In TRC, the value of T_{on} / T is varied in order to change the average output voltage.

37. What are the two types of TRC?

1. Constant frequency control
2. Variable frequency control

38. What is meant by FM control in a dc chopper?

In frequency modulation control, the chopping frequency f (or the chopping period T) is varied. Here two controls are possible.

1. On-time T_{on} is kept constant
2. Off period T_{off} is kept constant.

39. What is meant by PWM control in dc chopper?

In this control method, the on time T_{on} is varied but chopping frequency is kept constant. The width of the pulse is varied and hence this type of control is known as Pulse Width Modulation (PWM).

UNIT – III – Inverters

1. **What is meant by inverter?**

A device that converts dc power into ac power at desired output voltage and frequency is called an inverter.

2. **What are the applications of an inverter?**

- rrr. Adjustable speed drives
- sss. Induction heating
- ttt. Stand-by aircraft power supplies
- uuu. UPS
- vvv. HVDC transmission

3. **What are the main classification of inverter?**

- www. Voltage Source Inverter
- xxx. Current Source Inverter

4. **Why thyristors are not preferred for inverters?**

Thyristors require extra commutation circuits for turn off which results in decreased complexity of the circuit. For these reasons thyristors are not preferred for inverters.

5. **How output frequency is varied in case of a thyristor?**

The output frequency is varied by varying the turn off time of the thyristors in the inverter circuit, i.e. the delay angle of the thyristors is varied.

6. **Give two advantages of CSI.**

- 1. CSI does not require any feedback diodes.
- 2. Commutation circuit is simple as it involves only thyristors.

7. **What is the main drawback of a single phase half bridge inverter?**

It requires a 3-wire dc supply.

8. **Why diodes should be connected in anti-parallel with the thyristors in inverter circuits?**

For RL loads, load current will not be in phase with load voltage and the diodes connected in antiparallel will allow the current to flow when the main thyristors are turned off. These diodes are called feedback diodes.

9. **What types of inverters require feedback diodes?**

VSI with RL load.

10. What are the applications of a CSI?

1. Induction heating
2. Lagging VAR compensation
3. Speed control of ac motors
4. Synchronous motor starting.

11. What is meant by PWM control?

In this method, a fixed dc input voltage is given to the inverter and a controlled ac output voltage is obtained by adjusting the on and off periods of the inverter components. This is the most popular method of controlling the output voltage and this method is termed as PWM control.

12. What are the advantages of PWM control?

1. The output voltage can be obtained without any additional components.
2. Lower order harmonics can be eliminated or minimized along with its output voltage control. As the higher order harmonics can be filtered easily, the filtering requirements are minimized.

13. What are the disadvantages of the harmonics present in the inverter system?

1. Harmonic currents will lead to excessive heating in the induction motors. This will reduce the load carrying capacity of the motor.
- pppp. If the control and the regulating circuits are not properly shielded, harmonics from power ride can affect their operation and malfunctioning can result.
- qqqq. Harmonic currents cause losses in the ac system and can even some time produce resonance in the system. Under resonant conditions, the instrumentation and metering can be affected.
- rrrr. On critical loads, torque pulsation produced by the harmonic current can be useful.

20. What are the methods of reduction of harmonic content?

- ssss. Transformer connections
- tttt. Sinusoidal PWM
- uuuu. Multiple commutation in each cycle
- vvvv. Stepped wave inverters

21. Compare CSI and VSI.

S. No.	VSI	CSI
1.	Input voltage is maintained constant	Input current is constant but adjustable
2.	The output voltage does not depend on the load	The output current does not depend on the load
3.	The magnitude of the output current and its waveform depends on the nature of the load impedance	The magnitude of the output voltage and its waveform depends on the nature of the load impedance
4.	It requires feedback diodes	It does not requires feedback diodes

5.	Commutation circuit is complicated i.e. it contains capacitors and inductors.	Commutation circuit is simple i.e. it contains only capacitors.
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22. What are the disadvantages of PWM control?

SCRs are expensive as they must possess low turn-on and turn-off times.

23. What is meant by cyclo-converter?

It converts input power at one frequency to output power at another frequency with one-stage conversion. Cycloconverter is also known as frequency changer.

24. What are the two types of cyclo-converters?

- www. Step-up cyclo-converters
- xxxx. Step-down cyclo-converters

25. What is meant by step-up cyclo-converters?

In these converters, the output frequency is less than the supply frequency.

26. What is meant by step-down cyclo-converters?

In these converters, the output frequency is more than the supply frequency.

27. What are the applications of cyclo-converter?

- yyyy. Induction heating
- zzzz. Speed control of high power ac drives
- aaaaa. Static VAR generation
- bbbbb. Power supply in aircraft or ship boards

28. What is mean by VSI?

A VSI is one which the dc source has small or negligible impedance. In other words aVSI has stiff dc voltage source at its input terminals.

29. What is mean by CSI?

A current fed inverter or CSI is fed with adjustable current from a dc source of high impedance is from a stiff dc current source. —

30. What are the different types of PWM control?

- Single pulse width modulation
- Multiple pulse width modulation
- Sinusoidal pulse width modulation

31. What does AC voltage controller mean?

It is device, which converts fixed alternating voltage into a variable voltage without change in frequency.

32. What are the applications of ac voltage controllers?

- w. Domestic and industrial heating
- x. Lighting control
- y. Speed control of single phase and three phase ac motors
- z. Transformer tap changing

33. What are the advantages of ac voltage controllers?

- aa. High efficiency
- bb. Flexibility in control
- cc. Less maintenance

34. What are the disadvantages of ac voltage controllers?

The main draw back is the introduction of harmonics in the supply current and the load voltage waveforms particularly at low output voltages.

35. What are the two methods of control in ac voltage controllers?

- 1. ON-OFF control
- 2. Phase control