POWER ELECTRONICS
6th SEM EEE
Questions & Answers

UNIT – I

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.
i. Aerospace
ii. Commercial
iii. Industrial
iv. Telecommunications

3. Classify power semiconductor devices give examples.
i. Diodes: power diodes
ii. Thyristors: SCR
iii. Control switches: BJT, MOSFET and IGBT

4. What are the types of power transistors?
a) Bipolar Junction Transistor (BJT)
b) Metal Oxide Semiconductor Field Effect Transistor (MOSFET)
c) Insulated Gate Bipolar Transistor (IGBT)

5. Why IGBT is very popular nowadays?
a. Lower hate 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?
$\beta = \alpha / 1 - \alpha$ or $\alpha = \beta / 1 + \beta$

12. What are the different types of power MOSFET?
a. N-channel MOSFET
b. P-channel MOSFET

13. How can a thyristor 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?
i. Elimination of commutation of commutating components in forced commutation, resulting in reduction in cost, weight and volume.
ii. Reduction in acoustic noise and electromagnetic noise due to elimination of commutation chokes.
iii. 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.
a) AC and DC motor drives
b) UPS systems
c) Power supplies
d) 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?
i. Lower gate drive requirement
ii. Lower switching losses

iii. 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 Vbr.

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}.

16 MARK QUESTIONS:

1. Explain special features of thyristor, triac and GTO. Draw relevant diagrams.

2. Explain the constructions and switches charactertics of power MOSFETs.

3. Discuss the circuit arrangements that are necessary for proper operation of parallel-connected thyristors.

4. Explain the various types of triggering methods of SCR.

5. What are the problems in series and parallel operation of SCRs?. How they are overcome.

6. Compare SCRs with power transistors and mention their fields of applications.

7. Draw the V-I charactertics of an SCR and explain its shape. How do these charactertics change with gate current variation?

8. Discuss the turn-on and turn-off charactertics of GTO and how it can be turned on and off.

9. Explain with neat diagrams, the four modes of operation of a triac.

10. Explain the dynamic charactertics of a thyristor during turn-off. What type of protection is needed for a thyristor**?**

UNIT – II – PHASE CONTRLLED 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**.

i. Steel rolling mills, printing press, textile mills and paper mills employing dc motor drives.
ii. DC traction
iii. Electro chemical and electro-metallurgical process
iv. Portable hand tool drives
v. Magnet power supplies
vi. 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.
2. 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 in a controlled rectifier?
a. Input power factor is improved.
b. 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?
a. SCRs are subjected to a peak-inverse voltage of 2Vm in a fully controlled bridge rectifier. Hence for same voltage and current ratings of SCRs, power handled by mid-point configuration is about 2 times.
b. 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?
a.UJT firing circuit.

b. The cosine wave crossing pulse timing control.
c. 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.
$PF = (V_1 I_1 \cos \varphi_1) / (V_{rms} I_{rms})$
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?
a. Commutation is made simple.
b. Distortion on the ac side is reduced due to the reduction in lower order harmonics.
c.Inductance reduced in series is considerably reduced.

12. What does ac voltage controller mean?
It is device, which converts fixed alternating voltage into a variable voltage without change in frequency.

13. What are the applications of ac voltage controllers?
a. Domestic and industrial heating
b. Lighting control
c. Speed control of single phase and three phase ac motors
d. Transformer tap changing

14. What are the advantages of ac voltage controllers?
a. High efficiency
b. Flexibility in control
c. Less maintenance

15. 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.

16. What are the two methods of control in ac voltage controllers?
a. ON-OFF control
b. Phase control

17. What is the advantage of ON-OFF control?
Due to zero-voltage and zero current switching of thyristors, the harmonics generated by the switching action are reduced.

18. 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.

19. **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.

20. 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.

21. What is meant by unidirectional or half-wave ac voltage controller?
Here the power flow is controlled only during the positive half-cycle of the input voltage.

22. What are the disadvantages of unidirectional or half-wave ac voltage controller?
a. Due to the presence of diode on the circuit, the control range is limited and the effective RMS output voltage can be varied between 70% to 100%.
b. The input current and output voltage are asymmetrical and contain a dc component. If there is an input transformer, saturation problem will occur
c. It is only used for low power resistive load.

23. What is meant by bidirectional or half-wave ac voltage controller?
Here the power flow is controlled during both cycles of the input voltage

24. **What is the control range of firing angle in ac voltage controller with RL load**?
The control range is < <180 , where = load power factor angle

25. What type of gating signal is used in single phase ac voltage controller with RL load?
High frequency carrier gating signal is used for single phase ac voltage controller with RL load.

26. What are the disadvantages of continuous gating signal?
a. More heating of the SCR gate.
b. Increases the size of pulse transformer.

27. What is meant by high frequency carrier gating?
Thyristor is turned on by using a train of pulses from to . This type of signal is called as high frequency carrier gating.

28. Define Displacement Factor.
The input displacement factor is defined as the cosine of the input displacement angle.

29. Define voltage ripple factor.
It is defined as the ratio of the net harmonic content of the output voltage to the average output voltage.

30. What is mean by uncontrolled rectifier?
The uncontrolled rectifier uses only diodes and it converts fixed ac voltage into fixed dc voltage.

31. How to classify rectifier circuits.
(i) Uncontrolled rectifier
(ii) Controlled rectifier

32. 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.

33.What are the performance factors of line commutated converters?
Input displacement angle , input power factor, DC voltage ratio, Input harmonic factor, Voltage & current ripple factor.

34.What are the two configuration of single phase 2 pulse controlled rectifier?
i) Mid point converter
ii) Bridge Converter

35.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.

36.What is meant by rectification mode in single phase fully controlled converter?
In single phase full converter $< 90^0$ the voltage at the dc terminal is positive. Therefore, power flows from source to load & the converter operates as a rectifier. Source voltage is Vs & Current is positive. This is known as rectification mode.

37.What is meant by inversion mode?
In single phase full converter $> 90^0$ the voltage at the dc terminal is negative. Therefore, power flows from load to source & the converter operates as line commutated inverter. Source voltage Vs is negative & Current is positive. This is known as inversion mode or synchronous mode.

38.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.

39.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.

40.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 as thyristor converter.

41. What is meant by sequence control of ac voltage regulators?
It means that the stages of voltage controllers in parallel triggered in a proper sequence one after the other so as to obtain a variable output with low harmonic content.

42. What are the advantages of sequence control of ac voltage regulators?
a. System power factor is improved.
b. Harmonics are reduced in the source current and the load voltage.

12 MARK QUESTIONS:

1. Describe the working of single-phase fully controlled bridge converter in the rectifying mode and inversion mode. Also sketch the following waveforms for delay angle load voltage, load current and thyristor voltage.

2. Explain the operation of 3phase, 6pulse bridge converter with resistive load. Draw the output voltage, voltage across T1 and current waveform of T2 for = 0. list the firing sequence of SCR.

3. Explain the method of phase control with relevant sketches derive an expression for r.m.s. Output voltage.

4. Explain the operation of dual converter with a neat circuit diagram.

5. Draw the circuit diagram of single-phase full wave fully controlled rectifier with inductive load. Explain the operation of circuit relevant sketches. Explain the operation of freewheeling diode on the performance of this circuit.

6. Explain the operation of a fully controlled thyristor bridge converter. Also, device expressions for the average load voltage and input power factor.

7. With a neat diagram and output waveforms explain the operation of 3-phase, 6pulse converter. Device expression for the d.c output voltage. When the source impedance effect is neglected and load is resistive.

8. Draw the power circuit diagram of a six pulse, two-quadrent converter circuit. Explain the operation of the circuit with necessary waveforms.

9. Explain the inverting operating and conditions for inversion of a fully controlled converter with relevant circuit diagram and waveforms.

10. Explain the clearly the effects of load inductance and source inductance on the performance of controlled rectifiers.

UNIT – III DC – DC CHOPPERS

1. **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.

2. What are the types of commutation?
a. Natural commutation
b. Forced commutation

3. **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.

4. **What is meant by forced commutation?**
In this commutation, the current flowing through the thyristor is forced to become zero by external circuitry.

5. **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.

6. What are the applications of dc chopper?
a. Battery operated vehicles
b. Traction motor control in electric traction
c. Trolly cars
d. Marine hoists
e. Mine haulers
f. Electric braking.

7. What are the advantages of dc chopper?
Chopper provides
a. High efficiency
b. Smooth acceleration
c. Fast dynamic response
d. Regeneration

8. **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.

9. 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

10. **Write down the expression for average output voltage for step up chopper.**
Average output voltage for step down chopper $V_0 = Vs$,
α is the duty cycle

11. **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.

12. What are the two types of control strategies?
a. Time Ratio Control (TRC)
b. Current Limit Control method (CLC)

13. **What is meant by TRC?**
In TRC, the value of T_{on} / T is varied in order to change the average output voltage.

14. What are the two types of TRC?
a. Constant frequency control

15. **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.
a. On-time T_{on} is kept constant
b. Off period T_{off} is kept constant.

16. **What is meant by PWM control in dc chopper?**
In this control method, the on time Ton 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).

17. **Write down the expression for the average output voltage for step down and step up chopper.**
Average output voltage for step down chopper is $V_O = V_S$. Average output voltage for step up chopper is $V_O = V_S$ x [1/ (1-)].

18. What are the different types of chopper with respect to commutation process?
a. Voltage commutated chopper.
b. Current commutated chopper.
c. Load commutated chopper.

19. **What is meant by voltage commutation?**
In this process, a charged capacitor momentarily reverse biases the conducting thyristor and turn it off.

20. **What is meant by current commutation?**
In this process, a current pulse is made to flow in the reverse direction through the conducting thyristor and when the net thyristor current becomes zero, it is turned off

21. **What is meant by load commutation?**
In this process, the load current flowing through the thyristor either becomes zero or is transferred to another device from the conducting thyristor.

22. What are the advantages of current commutated chopper?
a. The capacitor always remains charged with the correct polarity.
b. Commutation is reliable as load current is less than the peak commutation current I_{CP}.
c. The auxiliary thyristor T_A is naturally commutated as its current passes through zero value.

23. What are the advantages of load commutated chopper?
a. Commutating inductor is not required.

b. It is capable of commutating any amount of load current.
c. It can work at high frequencies in the order of kHz.
d. Filtering requirements are minimal.

24. What are the disadvantages of load commutated chopper?
a) For high power applications, efficiency becomes very low because of high switching losses at high operating frequencies.
b) Freewheeling diode is subjected to twice the supply voltage.
c) Peak load voltage is equal to twice the supply voltage.
d) The commutating capacitor has to carry full load current at a frequency of half chopping frequency.
e) One thyristor pair should be turned-on only when the other pair is Commutated. This can be realized by sensing the capacitor current that is alternating.

25. How is the inverter circuit classified based on commutation circuitry?
a. Line commutated inverters.
b. Load commutated inverters.
c. Self commutated inverters.
d. Forced commutated inverters.

26.What are the different types of chopper configuration?
Depending upon the direction of current & voltages choppers can be classified into following types
1.Type A or First Quadrant chopper
2. Type B or Second Quadrant chopper
3. Type C or Two Quadrant type B chopper
4. Type D or Two Quadrant type C chopper
5. Type E or Four Quadrant chopper

27.What are the disadvantages of FM control?

The chopping frequency has to be varied over a wide range for the control of output voltage It generate harmonics at unpredictable frequencies

28. What are the disadvantages of voltage commutated chopper?

A starting circuit is required & the starting circuit should be switch that it triggers auxillary SCR TA first At the commutation occurs load voltage = 2Vs Turn off time is load dependent. It does not work at no load conditions

29.Write down the expression for average load current?
Io = (Vo - E) / R
Vo = Avg. output voltage
E = Back emf & R = load resistance

30.Write down the expression for commutating elements L & C for voltage commutated chopper?
$L < C (Vs/Io)^2$
$C = Io (toff + \Delta t) / Vs$

31.Differentiate between constant frequency & variable frequency control strategies of varying the duty cycle of DC chopper.

constant frequency control – Frequency of the chopper remains constant , but ON period is changed to vary the output. variable frequency control - Either Ton or Toff is kept constant & frequency is varied to change the output.

32. 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.

33. What are the types of commutation?
a. Natural commutation
b. Forced commutation

34. 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.

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

16 MARK QUESTIONS:

1. Describe the principle of step-up chopper. Derive an expression for the average output voltage in terms of input dc voltage and duty cycle. State the assumptions made.

2. For a type A chopper (first quadrant), express the following variables as a function of Vs, R and duty cycle in case the load is resistive average output voltage and current.

3. Explain the operation of a D.C chopper supplying power to a dc motor.

4. Derive an expression for load voltage and load current of a D.C chopper.

5. Compare ON-OFF control with Phase control and point out the relevant merits.

6. Explain the principle and operation of a Buk – Boost converter and relevant merits and demerits.

7. Explain the principle and operation of a Cuk converter and what are the merits and demerits of converter.

8. Explain the suitable waveforms the operation of a single quadrant kdc chopper with RL load.

9. With relevant diagram, explain two -quadrant operation of a DC chopper.

10. Show that Vout = Vin / 1- in step –up chopper. Explain the operation of the circuit.

11. What are the forced commutation circuits techniques used in chopper circuits? Explain.

UNIT – IV – 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?
a. Adjustable speed drives
b.Induction heating
c. Stand-by aircraft power supplies
d. UPS
e. HVDC transmission

3. **What are the main classification of inverter?**
a. Voltage Source Inverter
b. 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.
a. CSI does not require any feedback diodes.
b. Commutation circuit is simple as it involves only thyristors.

7. **What is the main drawback of a single phase half bridge inverter?**
It require a 3-wire dc supply.

8. **Why diodes should be connected in antiparallel 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 is meant a series inverter?**
An inverter in which the commutating elements are connected in series with the load is called a series inverter.

11. **What is the condition to be satisfied in the selection of L and C in a series inverter?**
$R_2 < 4L$
C
12. **What is meant a parallel inverter?**
An inverter in which the commutating elements are connected in parallel with the load is called a parallel inverter.

13. **What are the applications of a series inverter?**
The thyristorised series inverter produces an approximately sinusoidal waveform at a high output frequency, ranging from 200 Hz to 100kHz. It is commonly used for fixed output applications such as
a. Ultrasonic generator
b. Induction heating
c. Sonar Transmitter
d. Fluorescent lighting

14. How is the inverter circuit classified based on commutation circuitry?
a. Line commutated inverters.
b. Load commutated inverters.
c. Self commutated inverters.
d. Forced commutated inverters.

15. **What is meant by McMurray inverter?**
It is an impulse-commutated inverter, which relies on LC circuit and an auxiliary thyristor for commutation in the load circuit.

16. What are the applications of a CSI?
a. Induction heating
b. Lagging VAR compensation
c. Speed control of ac motors
d. Synchronous motor starting.

17. **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.

18. **What are the advantages of PWM control?**
a. The output voltage can be obtained without any additional components.
b. 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.

19. What are the disadvantages of the harmonics present in the inverter system?
a. Harmonic currents will lead to excessive heating in the induction motors. This will reduce the load carrying capacity of the motor.
b. If the control and the regulating circuits are not properly shielded, harmonics from power ride can affect their operation and malfunctioning can result.
c. 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.
d. On critical loads, torque pulsation produced by the harmonic current can be useful.

20. What are the methods of reduction of harmonic content?
a. Transformer connections
b. Sinusoidal PWM
c. Multiple commutation in each cycle
d. 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.

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?
a. Step-up cyclo-converters
b. 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?**
a. Induction heating
b. Speed control of high power ac drives
c. Static VAR generation
d. Power supply in aircraft or ship boards

28. **What is meant by positive converter group in a cycloconverter?**
The part of the cycloconverter circuit that permits the flow of current during positive half cycle of output current is called positive converter group.

29. **What is meant by negative converter group in a cycloconverter**?
The part of the cycloconverter circuit that permits the flow of current during negative half cycle of output current is called negative converter group.

30. **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.

31. **What is mean by VSI**?
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.

32. **What are the different methods of forced commutation employed in inverter circuits?**
i) Auxillary commutation
ii) complementary commutation

33. **What are the methods of voltage control inverters**?
External control of ac output voltage
External control of dc input voltage
Internal control of inverter

34. **What is meant by feedback diodes or retun current diodes?**
For RL loads current io will not be in phase with voltage & diodes connected in antiparallel with SCR will allow the current to flow when the main SCRs are turnwed off. These diodes are called feedback diodes.

35. **What are the different types of PWM control**?
Single pulse width modulation
Multiple pulse width modulation
Sinusoidal pulse width modulation

36. **How the thyristor inverters are classified**?
According to the method of communal
i. Line commutated inveter
ii. Forced commutated inverter
According to the connection
iii. series inveter
iv. parallel inverter
v. Bridge inverter

16 MARK QUESTIONS:

1. Describe the different operation of series inverter. What are the advantages?

2. State different methods of voltage control inverters. Describe about PWM control in inverter.

3. Explain the operation of three- phase bridge inverter with neat circuit diagram and waveforms.

4. With a circuit diagram and relevant waveforms, describe the working of singlephase inverter.

5. What are techniques in PWM method and explain any one.

6. Explain the operation of current source inverter with different modes.

7. Draw a three-phase bridge inverter for 120 mode operation and explain its working. Give relevant waveforms also.

8. Write a basic parallel Inverter Bridge and explain its working with output voltage waveforms, for different load pfs.

9. Explain the operation of auxiliary commutated bridge inverter. Draw necessary waveforms.

10. Explain with neat sketch and waveforms PWM inverter.

11. Explain the operation of a complementary commutated bridge inverter circuit. Draw necessary waveforms.

12. Explain the PWM control of single –phase inverter.

13. Discuss in detail the operation of a single-phase bridge inverter with necessary waveforms. Hi light the role played by the return current diodes in such inverters.

UNIT – V – APPLICATIONS

1. What are the applications of power electronics?
Variable speed electric drives
Temperature and illumination controllers
Power supplies
HVDC transmission

2. What are parameters controlled using facts?
Series impedance, shunt impedance, current, voltage, phase angle and damping frequencies.

3. What are the types of facts controllers?
Series controllers
Shunt controllers
Combined series-series controllers
Combined series-shunt controllers

4. What are the types HVDC transmission lines?
Monopolar line
Bipolar line
Homopolar line

5. What are the types of ac power supplies in static var system?
Switched –mode ac power supplies
Resonant ac power supplies
Bidirectional ac power supplies

6. Define Voltage mode control.
The duty cycle is increased to cause a subsequent increase in output voltage in the mode control is called voltage mode control.

7. Define current mode control.
The current mode control uses the current as the feedback signal to achieve output voltage control.

8. What are the different modes of controlling in drives?
Motoring mode
Reverse motoring mode (Braking mode)
Generating mode
Reverse generating mode

9. **What are the types of ac power supplies in static var system?**
Resonant ac power supplies
Bidirectional dc power supplies.

10. What are the types of various faults?
Phase failure (PF)
Gate Pulse Failure (GPF)
Turn-on Failure of Thyristor (TFT)

Short Circuit across Thyristor (SCT)
Short Circuit across DC Terminals (SCD)

11. **What is meant by SMPS?**
SMPS means Switch Mode Power Supply. SMPS is based on the chopper principle. Varying the duty cycle of chopper by PWM techniques controls the output dc voltage.

12. What are the types of SMPS?
Fly back SMPS
Push pull SMPS
Half bridge SMPS
Full bridge SMPS

13. **Advantages of SMPS.**
For the same power rating,
SMPS is of smaller size,
Lighter in weight and processes,
Higher efficiency,
High frequency operation
Less sensitive to input voltage variations.

14. Disadvantages of SMPS.
It has higher output ripple and regulation is worse.
It is a source of both electromagnetic and ratio interference due to high frequency switching.
Control of ratio frequency noise requires the use of filters on both input and output.

15. **Define thyristor valve.**
The term of thyristor valve, used on HVDC systems, denotes a number of thyristors connected in series and parallel to get the required voltage and current ratings.

16. What are the advantages static switches over electromechanical switches.
On time of a static switch (SS) is of the order of 3microseconds, it has therefore very high switching speed.
SS has no moving parts; its maintance is therefore very low.
SS has no bouncing at the time of turning on.
SS has long operational life.

17. Define static circuit breakers.
Static circuit breakers are semi conductor-based circuits capable of providing a fast and reliable interruption to a continuous current.

18. Define resonant converters.
The converter circuits, which employ zero-voltage and or zero current switching, are called resonant converters.

19. What are the types of resonant converters?
Zero Voltage Switching (ZVS)
Zero Current Switching (ZCS)

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

Transformer connections
Sinusoidal PWM
Multiple commutation in each cycle
Stepped wave inverters

21. **What are the disadvantages of the harmonics present in the inverter system?**
Harmonic currents will lead to excessive heating in the induction motors. This will reduce the load carrying capacity of the motor. If the control and the regulating circuits are not properly shielded, harmonics from power ride can affect their operation and malfunctioning can result. 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. On critical loads, torque pulsation produced by the harmonic current can be useful.

22. What is meant by PWM control in dc chopper?
In this control method, the on time Ton 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).

23. Mention some of the applications of controlled rectifier.
Steel rolling mills, printing press, textile mills and paper mills employing dc motor drives.
DC traction
Electro chemical and electro-metallurgical process
Portable hand tool drives
Magnet power supplies
HVDC

24. What is meant by sequence control of ac voltage regulators?
It means that the stages of voltage controllers in parallel triggered in a proper sequence one after the other so as to obtain a variable output with low harmonic content
.
25. What are the different methods to turn on the thyristor?
Forward voltage triggering
Gate triggering
dv/dt triggering
Temperature triggering
Light triggering

16 MARK QUESTIONS:

1. Draw the circuitry for a static circuit breaker and discuss its advantages and disadvantages.

2. What is the necessity for the UPS? Draw a block diagram for UPS and explain its operation.

3. Discuss the operation of the HVDC system and explain how the power flow can easily be controlled in both the directions. Also elaborate on its merits.

4. What is an SMPS? What are its advantages? Draw the circuit arrangement for SMPS and explain briefly its operation.

5. Give a short note on the Monopolar HVDC system.

6. State the advantages of HVDC over conventional ac transmission system. Draw the schematic diagram of dc bipolar transmission system and explain it briefly.

7. What are resonant converters? Give their advantages over PWM controlled converters.

8. Describe M-type ZCS resonant converter with relevant circuits and waveforms. Explain and draw the circuit diagram of shunt and series static var compensators? What are the advantages and disadvantages of static var compensators?