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Degree: / Branch : BE/EEE **Semester: VI / Year: III**

Subject Code & Title : 12E605 POWER ELECTRONICS

Part A

UNIT - 1 (POWER SEMICONDUCTOR DEVICES)

1. Define latching and holding current of SCR.
2. Classify power semiconducting devices based on it's control strategy. Give examples for each.
3. List any four advantages of IGBT over MOSFET.
4. What is the difference between conduction loss and switching loss?
5. Draw the symbol of IGCT and write any two applications.
6. State the SOA of BJT and give its significance.
7. Sketch the two transistor model of IGBT and its symbol.
8. Mention any two advantages and disadvantages of TRIAC.
9. Define commutation and give its types.
10. Give any four applications of GTO.
11. What are the advantages of GTO over SCR?
12. Define circuit turn-off time.
13. Define reverse recovery time in SCR.
14. What is the difference between power diode and signal diode?
15. Why circuit turn off time should be greater than the thyristor turn-off time?
16. Write the different methods to turn on thyristor?
17. What is an IGBT? What are the different types of IGBT?
18. Define rise time in thyristor.

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19. Compare SCR with TRIAC.
20. What are the advantages of GTO over BJT?

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Part B

UNIT - 1 (POWER SEMICONDUCTOR DEVICES)

1 i) Explain the structure and VI characteristics of SCR with suitable diagram. (8)

ii) With neat diagram brief out the switching characteristics of MOSFET. (4)

iii) Compare SCR and TRIAC. (4)

2 i) If the latching current in the circuit shown in fig (i). is 4mA, obtain the minimum width of the gating pulse required to properly turn-on the SCR. (4)

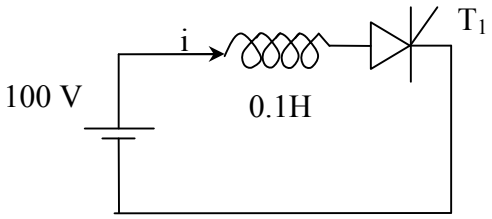

Fig (i)

ii) Brief out the switching characteristics of IGBT with near sketch (6)

iii) Draw and explain the Resistance firing circuit of the thyristor. (6)

3 i) The latching current of thyristor circuit with RL load is 50mA. The duration of the firing pulse is 50ms. The value of R=20Ω and L=0.5H. Will the device get fired? If the device does not get fired, then what should be the preferable duration of firing pulse to get latched? (8)

ii) Give the comparison of GTO with SCR. (4)

iii) Sketch the switching characteristics of a thyristor during its turn-on and turn-off processes. (4)

4 i) Explain the V-I characteristics of SCR with relevant diaragm. (6)

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	ii)	Explain the switching characteristics of MOSFET with necessary wave-forms.	(6)
	iii)	Compare MOSFET with BJT.	(4)
5	i)	Explain the different modes of operation and V-I characteristics of TRIAC.	(7)
	ii)	Derive the condition for the occurrence of latch up in SCR using two transistor analogy.	(5)
	iii)	State the differences between TRIAC and SCR.	(4)
6	i)	Explain the switching performance of IGBT with relevant waveforms indicating clearly the turn-on and turn-off times and their components.	(6)
	ii)	Describe the resistance firing circuit used for triggering SCRs. Is it possible to get firing angle greater than 90° with resistance firing? Illustrate your answer with appropriate waveforms.	(6)
	iii)	Draw and describe the output characteristics of BJT.	(4)
7	i)	Compare any four power semiconductor devices	(4)
	ii)	Discuss the switching characteristics of GTO with neat sketch	(8)
	iii)	Explain the salient features of IGBT and MOSFET.	(4)
8	i)	Draw the structure of IGCT.	(3)
	ii)	Explain the basic structure and operation of GTO.	(6)
	iii)	With neat diagram explain the switching characteristics of a thyristor	(7)

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9	i)	Give the structures of i) MOSFET, II) BJT, III) IGBT	(3)
	ii)	Draw and explain the full wave RC firing circuit of the thyristor.	(6)
	iii)	Discuss the different modes of operation of TRIAC with relevant diagram.	(7)
10	i)	Draw and explain the half wave RC firing circuit of the thyristor.	(6)
	ii)	Explain the principle of pulse generation using UJT triggering circuit.	(7)
	iii)	Sketch the transfer characteristics of MOSFET.	(3)

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Subject Code & Title: 12E605 & Power Electronics

Part-A (2 MARKS)

UNIT – II CONTROLLED RECTIFIERS

1. Differentiate controlled rectifier and uncontrolled rectifier.
2. List any four applications of phase controlled rectifier.
3. Define firing angle with respect to controlled rectifier.
4. Write any four functions of freewheeling diode in controlled rectifier.
5. Give an expression for average dc load voltage of single phase semi-converter with RL load.
6. Give an expression for average dc load voltage of single phase fully controlled converter with RL load.
7. Give an expression for average dc load voltage of three phase fully controlled converter with R load.
8. Draw the circuit of single phase symmetrical half controlled bridge rectifier with resistive load.
9. State the condition to make fully controlled converter operate in inversion mode.
10. Compare half controlled bridge rectifier with fully controlled bridge rectifier.
11. Determine the output voltage for the triggering angle α=90° in a single phase half controlled converter feeding R load with the supply of 230V.
12. Mention any four advantages of six pulse converter over two pulse converter.
13. A three phase half wave controlled rectifier has a supply of 150V/phase. Determine the load voltage for the delay angle of 30°. Assume continuous load current.
14. Draw the circuit diagram of three phase fully controlled bridge rectifier with RL load.
15. What is dual converter?
16. Mention the two operating modes of a dual converter.

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17. Define extinction angle.
18. Mention the condition to achieve continuous conduction in RL load.
19. Sketch the output voltage waveform for single phase fully controlled bridge rectifier for R load at α=30°
20. Write the range of firing angle and extinction angle in fully controlled rectifier.

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Part- B (16 marks)

UNIT – 2 (CONTROLLED RECTIFIERS)

1 i) Explain with necessary waveforms the operation of single phase half controlled thyristor bridge converter with RLE load. (6)

ii) Explain the operation of single phase fully controlled thyristor bridge rectifier with RL Load. (6)

iii) Derive an expression for average dc load voltage, load current, RMS voltage and RMS current of single phase full-converter with RL load. (4)

2 i) A single phase controlled rectifier bridge consists of one SCR and three diodes as shown in fig (i). Sketch the output voltage waveform for a firing angle of α for the SCR and hence obtain an expression for the average output voltage. (6)

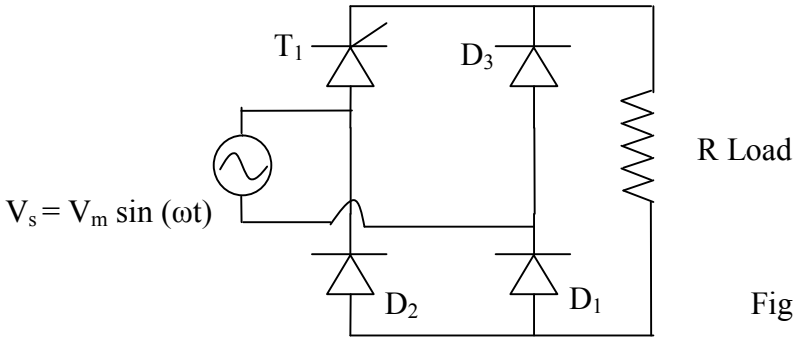

Fig (i)

ii) Discuss the operation of three phase fully controlled converter feeding R load with necessary diagrams. (6)

iii) Draw the circuit diagram and output waveform of single phase dual converter for non-circulating current mode. (4)

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3	i)	With necessary circuit diagram, brief out the operation of single phase half controlled thyristor bridge converter with R load	(9)
	ii)	Sketch the waveform of single phase semiconverter with Rload.	(3)
	iii)	Derive an expression for average dc load voltage, load current, RMS voltage and RMS current of single phase semiconverter with Rload.	(4)
4	i)	Explain the operation of single phase fully controlled thyristor bridge rectifier for R Load with suitable diagrams.	(7)
	ii)	Derive the output dc load voltage equation of single phase fully controlled thyristor bridge rectifier with R Load	(4)
	iii)	A single phase full wave converter is operated from a 120v, 60Hz for a resistive load of 10ohm. If the average output voltage is 25% of maximum possible average output voltage, find i) the delay angle ii) average and rms output current.	(5)
5	i)	Explain the circulating current mode operation of single phase dual converter with suitable diagram and waveforms	(7)
	ii)	Discuss the operation of three phase fully controlled converter for RL load with necessary diagrams for $\alpha=60°$.	(6)
	iii)	Write any four applications of phase controlled converters.	(3)
6	i)	Discuss the operation of three phase semiconverter with Rload.	(7)
	ii)	Sketch the waveform for three phase semiconverter with R load for $\alpha=30°$.	(4)
	iii)	Derive the dc load voltage equation for three phase semiconverter with R load	(5)
7	i)	Explain the operation of three phase half controlled converter for RL load with necessary waveforms	(10)

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ii) Write any four functions of freewheeling diode in controlled rectifier (3)

iii) State the condition for operating the three phase full converter in inversion mode. (3)

8 i) Explain the operation of three phase full controlled converter for RLE load with suitable circuit diagram. (6)

ii) Explain the non-circulating current mode operation of single phase dual converter with suitable diagram and waveforms (6)

iii) Derive the output RMS load voltage equation of single phase fully controlled thyristor bridge rectifier with R Load (4)

9 i) What will happen if one of the devices namely T_3 in single phase half controlled converter does not operate? (6)

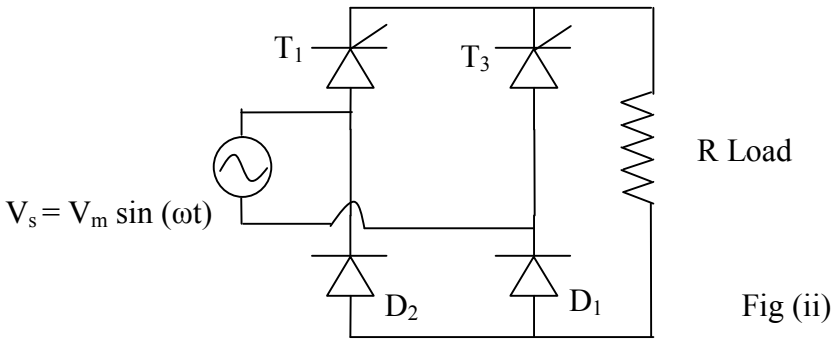

Fig (ii)

ii) Derive the output dc voltage equation for the waveform obtained from fig (ii) (6)

iii) Compare half controlled rectifier and fully controlled rectifier. (4)

10 A three phase fully controlled bridge converter operating from a 3 phase 220 V, 50 Hz supply is used to charge a battery bank with nominal voltage of 240 V. The battery bank has an internal resistance of 0.01 Ω and the battery bank voltage varies by ± 10% around its nominal value between fully charged and uncharged condition. When the

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battery bank is charged with a constant average charging current of 100 Amps through a 250 mH lossless inductor. Assuming continuous conduction find out.

(i) The range of firing angle of the converter. (6)

(ii) The range of ac input power factor. (4)

(iii) The range of charging efficiency. (6)

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Part A

UNIT - 3 (CHOPPERS AND ITS APPLICATIONS)

1. List any two disadvantages of Frequency Modulation used in Chopper.
2. Enumerate the methods of controlling the output voltage of a chopper?
3. List any two advantages and disadvantages of Buck–Boost Converter.
4. Compare constant frequency control with variable frequency control.
5. Define Time Ratio Control and write its types.
6. Define Current Limit Control.
7. How is chopper is classified based on their quadrant of operation?
8. What are the basic topologies of switching regulator?
9. Define the term duty cycle in DC – DC converter.
10. What are the advantages of Cuk converter?
11. List the advantages of choppers.
12. Write down the expression for an average output voltage of step up and step down chopper.
13. Mention any four applications of dc choppers.
14. Sketch the diagram of basic step-up chopper.
15. Draw the circuit diagram for Cuk converter.
16. Compare the output voltage of buck, boost, buck-boost converter.
17. Write the difference between AC link chopper and dc chopper.
18. Determine the output voltage of step up chopper with 20% duty cycle fed from an 80V DC source.

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19. Draw the circuit diagram for buck-boost regulator.
20. A boost regulator has an input voltage of 10V. The average output voltage is 15V and the average load current is 0.4A. The chopping frequency is 20kHz. Assume the value of inductor is 100μH. Calculate the duty ratio.

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Part B

UNIT - 3 (CHOPPERS AND ITS APPLICATIONS)

1	i)	Discuss the principle of operation of a step-down chopper with relevant diagrams and derive its output voltage.	(8)
	ii)	Explain briefly about the Time ratio control in choppers.	(4)
	iii)	In a step down chopper, the input voltage is 230V dc, the load voltage is 150V. if the chopping frequency is 5kHz, find the chopping period and blocking period of the chopper.	(4)
2	i)	Discuss the principle of operation of a step-up chopper with suitable diagrams and derive its output voltage.	(8)
	ii)	Explain the current limit control in choppers.	(4)
	iii)	A step up chopper has input voltage of 220V and output voltage of 660V. If the non-conducting time of thyristor is 100µsec. Compute the pulse width of output voltage. If the pulse width is halved for a constant frequency operation, find the new output voltage.	(4)
3	i)	Draw the circuit diagram of buck converter. Derive the output voltage equation, peak to peak ripple current of inductor, peak to peak ripple voltage of capacitor.	(8)
	ii)	The buck regulator has an input voltage of 12 v. The required output voltage is v=5 v and the peak to peak output ripple voltage is 20mv. The switching frequency is 25 kHz. If the peak to peak ripple current of inductor is limited to 0.8A, determine, a) Duty cycle, b) Filter inductance, c) Filter capacitance	(4)

iii) Write any four advantages and disadvantages of buck converter. (4)

4 i) Draw the circuit diagram of boost converter. With its operation, derive the output voltage equation, peak to peak ripple current of inductor, peak to peak ripple voltage of capacitor. (8)

ii) A boost regulator has an input voltage of 10V. The average output voltage is 15V and the average load current is 0.4A. The chopping frequency is 20kHz. Assume the value of inductor is 100μH. Calculate the duty ratio, ripple current of inductor. (4)

iii) Enumerate the types of chopper and give any 4 applications of choppers (4)

5 i) Draw the circuit diagram of buck-boost converter and explain its operation with equivalent circuit for different modes and waveforms. (7)

ii) The buck-boost regulator has an input voltage of 12 v. the duty cycle is 0.25 and the switching frequency is 25 kHz. The inductance L=150μH and filter capacitance c=220μF. the average load current is 1.25 A. Determine a) The average output voltage, b) The peak to peak output voltage ripple, c) The peak to peak output current ripple, d) The peak current of switch (5)

iii) What is Pulse Width Modulation? Why is the Frequency Modulation not suitable for choppers? (4)

6 i) Draw the circuit diagram of cuk converter and explain its operation with equivalent circuit for different modes and waveforms. (5)

ii) With appropriate waveforms, describe the different control strategies used for obtaining variable output voltage from a dc chopper. (6)

iii) A dc chopper is connected to an inductive load with a resistance of 5Ω. On time and off time of the chopper is 20ms and 10ms respectively. The dc supply voltage is 300v. estimate i) Duty ratio, ii) Chopping frequency, iii) Average load voltage, iv) Average load current. (5)

7 i) A stepup chopper has an input voltage of 220v and output voltage of 660v. If the conducting time of thyristor-chopper is 100micro-sec, compute the pulse width of output (5)

voltage. In case output voltage pulse width is halved for constant frequency operation, find the average value of new output voltage.

ii) Discuss the principle of operation of a step-up chopper with suitable diagrams and derive its output voltage. (8)

iii) Compare PWM with frequency modulation of chopper. (3)

8 i) Explain the principle of operation of choppers with its necessary circuit and waveforms. (3)

ii) In a type A chopper, the input voltage is 230v. The load resistance is 10ohm and there is a voltage drop of 2v across the chopic thyristor when it is ON for a duty ratio of 0.4. Calculate the average and RMS value of output voltage. Also find the chopper efficiency (6)

iii) List any four advantages and applications of DC chopper. (7)

9 i) Draw the circuit diagram of boost converter. Derive the output voltage equation, peak to peak ripple current of inductor, peak to peak ripple voltage of capacitor. (8)

ii) A boost regulator has an input voltage of 5V. The average output voltage is 15V and average load current is 0.5 A. The switching frequency is 25 kHz. If L=150 μH and c=220 μF, determine a) duty cycle, b) ripple current of inductor, c) ripple voltage of filter capacitor (5)

iii) What is cuk regulator? Give its advantages and disadvantages over other regulators. (3)

10 i) Draw the circuit diagram of buck converter and derive the output voltage equation, peak to peak ripple current of inductor, peak to peak ripple voltage of capacitor. (6)

ii) Describe the principle of dc chopper operation. Derive an expression for its average dc output voltage. (7)

iii) Compare the output voltage of buck, boost, buck-boost converters. (3)

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Part-A (2 MARKS)

UNIT – IV INVERTERS AND CYCLOCONVERTERS

1. Mention the applications of an inverter.
2. Differentiate current source inverter and voltage source inverter.
3. Why is SCR not preferred for inverters?
4. Mention the types of control strategies of AC voltage controller.
5. What is the main drawback of a single phase half bridge inverter?
6. Why diodes should be connected in anti parallel with switches in inverter circuits?
7. Write the different modulation techniques used in inverters.
8. Define amplitude modulation index.
9. Define frequency modulation index.
10. State the condition to be satisfied in the selection of L and C in a series inverter.
11. Define Total harmonic distortion.
12. List any four applications of a series resonant inverter.
13. Give any four applications of a current source inverter.
14. State the principle of phase angle control.
15. What are the advantages of PWM control?
16. Mention the effect of harmonics in inverter.
17. Compare AC voltage controller with cycloconverter.
18. Write any four applications of ac voltage controllers.
19. Mention the control range of firing angle in AC voltage controller with RL load.

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20. List any four applications of cycloconverter.
21. Draw the input and output voltage waveform of single phase cycloconverter for an output frequency of 100 Hz.

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UNIT – 4 (INVERTERS AND CYCLOCONVERTERS)

Part- B (16 marks)

1 i) With neat diagram and necessary waveforms, explain the operation of three phase bridge inverter for 120^o mode of conduction (9)

ii) Derive the expression for RMS output voltage of a full wave A.C Voltage controller feeding R load. (4)

iii) Write any four applications of a series inverter. (3)

2 i) Discuss the operation of single phase step up cycloconverter for an output frequency of 100 Hz. (7)

ii) Explain different PWM techniques in detail. (5)

iii) A single phase half bridge inverter has a resistive load R=4ohm and the dc input voltage V_s=50V. Calculate

the RMS output voltage at the fundamental frequency V_1

the output power P_0

the average and peak current of each thyristor (4)

3 i) Explain the 180 degree mode of conduction of an inverter with relevant diagrams and waveforms. (10)

ii) List any five industrial applications of inverters. (3)

iii) Give the effects of harmonics present in the inverter system. Write the methods to reduce the harmonic content. (3)

4 i) Explain the principle operation of single phase half bridge inverter. (8)

ii) Derive the RMS output voltage equation for single phase half bridge inverter. (4)

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iii) Compare 120° with 180° mode of conduction of inverters. (4)

5 i) Explain briefly the Voltage and Harmonic Control techniques. (8)

ii) A single phase full bridge inverter has a resistive load of R=3Ω, and the dc input voltage V_{dc} =50V. Compute a) RMS value of the output voltage at the fundamental frequency V_1 , b) the output power , c) the average and peak currents of each thyristor. (5)

iii) Give any four applications of current source inverter. (3)

6 i) Explain briefly about Series resonant Inverter with necessary diagrams. (7)

ii) With relevant circuit and waveforms, describe the working of single phase full bridge inverter with R load (4)

iii) Describe Multiple PWM. (5)

7 i) Explain the operation of Current Source Inverter with neat sketch. (10)

ii) With relevant circuit and waveforms, describe the working of single phase full bridge inverter with RL load (3)

iii) Explain Sinusoidal PWM. (3)

8 i) State the need for controlling the output voltage of inverters? Write the methods for controlling it. (3)

ii) Explain Modified Sinusoidal PWM. (6)

iii) Discuss the operation of single phase step down cycloconverter for an output frequency of 25 Hz. (7)

9 i) Explain single phase bidirectional AC voltage controller with R Load (6)

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	ii)	Discuss the operation of three phase to single phase cycloconverter	(6)
	iii)	Write any four applications of Series Resonant Inverter.	(4)
10	(i)	Explain single phase bidirectional AC voltage controller with RL Load	(7)
	(ii)	Explain the operation of Series Resonant Inverter.	(6)
	(iii)	Compare Multiple PWM with sinusoidal PWM.	(3)

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Part – A (2 marks)

UNIT – V PROTECTION AND COOLING OF POWER SWITCHING DEVICES

1. Why heat sink and cooling arrangements are employed for power switching devices?
2. How is the effect of over voltages minimized?
3. Mention the two types of selenium voltage limiter.
4. Mention the uses of crowbar circuit.
5. State the necessity of snubber circuit.
6. How an over current occurs in thyristor circuits?
7. How the effect of radio interference phenomenon is minimized?
8. Mention the three ways of heat transfer.
9. Differentiate conduction, convection and radiation.
10. Write the expression for the capacitor in the design of snubber used for dv/dt protection.
11. What is thermal resistance?
12. Define heat capacity.
13. List the five types of thyristor mounting techniques.
14. Compare electrical failure with mechanical failure.
15. Compare thermal failure with electrical failure.
16. What is the use of Metal Oxide Varistors (MOV) for the protection against over voltages and voltage transients?

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17. Calculate the required parameters for snubber circuit to provide dv/dt protection to a SCR used in single phase bridge converter. The SCR has a maximum dv/dt capability of 60V/μsec. The input line voltage has a peak value of 425 volts and the source inductance of 0.2mH.
18. Write the expression for the resistance in the design of snubber used for dv/dt protection.
19. Mention the faults that require protection in switching devices?
20. What is the need for protection circuits in switching devices?

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(Autonomous)
Coimbatore -32

Degree: B.E / Branch: EEE **Semester: VI / Year: III**

Subject Code &Title: 12E605 & POWER ELECTRONICS

UNIT – 5 (PROTECTION AND COOLING OF POWER SWITCHING DEVICES)

Part- B (16 marks)

1	i)	Why heat sink and cooling arrangements are employed for power switching devices?	(3)
	ii)	Explain clearly the over voltage protection in forced commutation circuits.	(10)
	iii)	How an over current can occur in thyristor circuits?	(3)
		(OR)	
2	i)	Draw the thermal equivalent circuit for an SCR and discuss the various parameters involved in it.	(7)
	ii)	How is the effect of radio interference phenomenon minimized?	(3)
	iii)	Explain the various thyristor mounting techniques in detail	(6)
3	i)	What are the causes of over voltages and over current in thyristor circuits?	(7)
	ii)	Explain the heat transfer process in thyristor.	(5)
	iii)	What is the effect of internal faults in power-Electronic circuit?	(4)
4	i)	Explain in detail the various overvoltage conditions of an SCR.	(7)
	ii)	Draw the thermal equivalent circuit for an SCR and discuss the various parameters involved in it.	(6)
	iii)	What are the problems of fusing dc circuits?	(3)
5	i)	Explain in detail, the practical overvoltage protection in naturally commutated circuits.	(7)
	ii)	Explain the various thyristor mounting techniques in detail.	(5)
	iii)	Explain the heat transfer process in thyristor.	(4)
6	i)	Explain clearly the overvoltage protection in forced commutated circuits.	(6)
	ii)	Explain heat-sink specifications in detail.	(6)

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	iii)	Explain pressure mounting technique of thyristor in detail.	(4)
7	i)	What is meant by radio interference of SCRs? How is it minimized?	(5)
	ii)	Discuss the causes of over current in thyristor circuits.	(6)
	iii)	Explain selenium surge suppressor in detail.	(5)
8	i)	Explain in detail the various over current conditions.	(7)
	ii)	What are the causes of voltage transients on load side and supply side?	(3)
	iii)	How the voltage transients are suppressed?	(6)
9	i)	Explain how fault-current is caused by the commutation failure.	(5)
	ii)	Brief out the RF filters for minimizing radio interference phenomenon in thyristors.	(5)
	iii)	Describe the SCR crowbar circuit for overvoltage and over current protection.	(6)
10	i)	What is heat sink? What is it necessity? What are the different types of heat sink? How is a heat sink mounted? Why is it coated black?	(5)
	ii)	Design the snubber network for ac circuit.	(5)
	iii)	What would happen if inversion failure occurs in naturally commutated circuit?	(6)

Staff In-Charge **HOD/ EEE**

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