



**SREENIVASA INSTITUTE of TECHNOLOGY and MANAGEMENT  
STUDIES (autonomous)**

## **Power Electronics**

### *Question bank*

III - B.TECH / V- SEMESTER

regulation: R20

**Compiled by**

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**Department** : **EEE**



**PRE-REQUISITES:** A Course on Electronic Devices and Circuits

**COURSE EDUCATIONAL OBJECTIVES:** On successful completion of the course, students will be able to

1. Impart knowledge on Different types of power semiconductor devices and their switching.
2. Impart knowledge on Operation, characteristics and performance parameters of controlled rectifiers.
3. Impart knowledge on Operation, switching techniques and basics topologies of DC-DC switching regulators.
4. Impart knowledge on Different modulation techniques of pulse width modulated inverters and to understand harmonic reduction methods.
5. Impart knowledge on Operation of AC voltage controller and various configurations.

**UNIT – 1: : POWER SEMI-CONDUCTOR DEVICES AND COMMUTATION CIRCUITS**

Thyristors – Silicon Controlled Rectifier (SCR) – BJT – Power MOSFET – Power IGBT- DIAC, TRIAC and their characteristics – Basic theory of operation of SCR – Static characteristics –Dynamic characteristics of SCR - Turn on and Turn off times - Two transistor analogy – Series and parallel connections of SCR’s – Snubber circuit details – SCR turn on methods – R and RC Triggering - UJT firing circuit - Ratings of SCR’s..

**UNIT – 2: PHASE CONTROLLED RECTIFIERS**

Phase control technique – Single phase Line commutated converters – Midpoint, Bridge, and Semi controlled converters with R and RL loads–Derivation of average load voltage and current -Active and Reactive power inputs to the converters without and with Freewheeling Diode- Effect of source inductance. Three phase converters – Three pulse and six pulse converters – Full bridge connections -Average load voltage With R and RL loads – Effect of Source inductance–Dual converters (both single phase and three phase) – Waveforms.

**UNIT – 3: CHOPPERS**

Choppers – Time ratio control and Current limit control strategies – Step down choppers Derivation of load voltage and currents with R - RL and motor loads- Step up Chopper – Step up down Chopper –Chopper configurations-Chopper commutation-Morgan’s chopper and Jones chopper (Principle of operation only). AC chopper.

**UNIT – 4: INVERTERS**

Inverters – Single phase inverter – Basic series inverter – Basic parallel Capacitor inverter Bridge inverter – Waveforms – Mc Murray and Mc Murray Bedford inverters - Voltage control techniques for inverters-Pulse width modulation techniques. Three phase bridge VSI -180° and 120° mode of operation. Current source inverter. UPS basic configurations.

**UNIT – 5: AC VOLTAGE CONTROLLERS AND CYCLO CONVERTERS**

AC voltage controllers – Single phase two SCR’s in anti parallel – With R and RL loads – modes of operation of Triac – Triac with R and RL loads – Derivation of RMS load voltage current and power factor wave forms –Firing circuits Cyclo converters – Single phase midpoint cyclo converters with Resistive and inductive load (Principle of operation only) – Bridge configuration of single phase cyclo converter (Principle of operation only) – Waveforms..

**Course Outcomes:**

<b>On successful completion of the course, students will be able to</b>		<b>POs related to COs</b>
<b>CO1</b>	Acquire the knowledge on power semiconductor devices.	PO1,PO3,PO4 & PSO1,PSO2
<b>CO2</b>	Analyze the various phase-controlled converters and acquire knowledge on real time applications involved AC-DC converter.	PO1,PO2,PO3,PO4, PO5 & PSO1, PSO2
<b>CO3</b>	Analyze the various DC-DC converters and acquire knowledge on real time applications involved DC-DC converter.	PO1,PO2,PO3,PO4, PO5 & PSO1, PSO2
<b>CO4</b>	Analyze the single phase and three phase inverters and acquire knowledge on real time applications involved DC- AC inverter	PO1,PO2,PO3,PO4 ,PO5, PO6, PO12 & PSO1, PSO2
<b>CO5</b>	Analyze the various AC-AC converters and acquire knowledge on real time applications involved AC-AC converter.	PO1, PO3 & PSO1, PSO2



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DEPARTMENT of ELECTRICAL AND ELECTRONICS ENGINEERING

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### Text Books:

1. M.H. Rashid, 'Power Electronics: Circuits, Devices and Applications', Pearson Education, Third Edition, New Delhi, 2004.
2. P.S.Bimbra "Power Electronics" Khanna Publishers, third Edition, 2003.
3. Ashfaq Ahmed 'Power Electronics for Technology', Pearson Education, Indian reprint, 2003.

### Reference Books:

1. Joseph Vithayathil, 'Power Electronics, Principles and Applications', McGraw Hill Series, 6th Reprint, 2013
2. Philip T. Krein, "Elements of Power Electronics" Oxford University Press, 2004 Edition
3. L. Umanand, "Power Electronics Essentials and Applications", Wiley, 2010.
4. Ned Mohan Tore. M. Undel and, William. P. Robbins, 'Power Electronics: Converters, Applications and Design', John Wiley and sons, third edition, 2003
5. S. Rama Reddy, 'Fundamentals of Power Electronics', Narosa Publications, 2014.

### REFERENCE WEBSITE LINK:

<https://nptel.ac.in/courses/108/102/108102145/>

### CO-PO MAPPING:

CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3		3	3									2	3
CO2	3	3	3	3	3								2	3
CO3	3	3	3	3	3								2	3
CO4	3	3	3	3	3	1						1	2	3
CO5	3		3										2	3
CO	3	3	3	3	3	1						1	2	3



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Question No.	Questions	PO Attainment
<b>UNIT – 1: POWER SEMI-CONDUCTOR DEVICES AND COMMUTATION CIRCUITS</b>		
<b>PART-A (Two Marks Questions)</b>		
1	Why IGBT is very popular now a days	PO1
2	What are the different turn-on methods of thyristor	PO1
3	Why MOSFET is a voltage controlled device	PO2
4	Why BJT is a current controlled device	PO1
5	What are the different turn-on methods of thyristor	PO1
6	Define Latching current	PO1
7	Define Holding current	PO1
8	What is a snubber circuit	PO1
9	How can a thyristor turned off	PO1
10	What losses occur in a thyristor during working conditions	PO2
11	Define hard-driving	PO1
12	Define Circuit turn-off time	PO1
13	Why Circuit turn-off time is greater than thyristor turn-off time	PO1
14	What is the turn-off time of SCR	PO1
15	Describe the characteristics of a thyristor	PO2
16	Classify power semiconductor devices and give examples	PO1
17	What is Commutation	PO1
18	Explain the turn-on process of a thyristor	PO1
19	What is the two-transistor model of a thyristor	PO2
20	What are advantages of thyristor in power electronics	PO2
<b>PART-B (Ten Marks Questions)</b>		
1	Discuss the different modes of operation of thyristor with the help of static V-I characteristics	PO1, PO2
2	Explain the construction of SCR with a neat sketch	PO1,PO2, PO4
3	Draw and explain the Switching Characteristics of SCR	PO1, PO2
4	What are the different turn-on methods of SCR? Explain in detail	PO1,PO2, PO4
5	What are the differences between IGBT and MOSFET	PO1,PO2, PO4
6	Explain the Switching Characteristics of TRIAC	PO1,PO2, PO4
7	Discuss the different modes of operation of TRIAC with the help of V-I characteristics	PO1,PO2, PO4
8	What are the firing circuits of SCR, explain in detail	PO1,PO2, PO4
9	Explain series and parallel connections of SCR	PO1,PO2, PO4
10	Discuss the voltage ratings of SCR	PO1,PO2, PO4
Question No.	Questions	PO Attainment
<b>UNIT – 2: PHASE CONTROLLED RECTIFIERS</b>		
<b>PART-A (Two Marks Questions)</b>		
1	What is meant by phase controlled rectifier	PO1
2	Mention some of the applications of controlled rectifier	PO1
3	Give any two differences single phase full and semi converter?	PO1
4	Define current ripple factor	PO1



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5	What is dual converter	PO1
6	What is the function of freewheeling diodes in controlled rectifier	PO1
7	What are the advantages of freewheeling diodes in a controlled rectifier?	PO1
8	What is meant by delay angle	PO1
9	Give an expression for average voltage of single phase semi converters	PO1
10	What is meant by input power factor in controlled rectifier	PO1
11	Define displacement factor	PO1
12	Define voltage ripple factor	PO1
13	What is mean by full converter	PO1
14	What are the two configuration of single phase 2 pulse controlled rectifier	PO1, PO2
15	What is meant by 2 pulse converter	PO1
16	What is meant by rectification mode in single phase fully controlled converter?	PO1, PO2
17	What is meant by inversion mode	PO1
18	What is turn off time for two pulse converter	PO1
19	Why is power factor of semi converter better than full converter?	PO1
20	What is the effect of source impedance on the performance converter	PO1
<b>PART-B (Ten Marks Questions)</b>		
1	Explain the operation of a single phase full bridge converter with RL load with a neat sketch and also derive the expression for average output voltage	PO1, PO2, PO4
2	A single phase full bridge converter is connected to 'R' load. The source voltage is of 230 V, 50 Hz. The average load current is of 10 A. For R=20Ω, Find the firing angle.	PO1, PO2, PO4
3	A 230V, 50Hz supply is connected to load resistance of 12 Ω through half controlled rectifier. if the firing angle is 60 degree & determine (i)Average output voltage (ii) Rms output voltage (iii) Ratio of rectification (iv)TUF	PO1, PO2, PO4
4	Describe the operation of a single phase two pulse bridge converter with R-load using 4 SCR'S with relevant waveforms	PO1, PO2, PO4
5	Explain the operation of single phase half controlled rectifier with inductive load. Also derive an expression for the average output voltage	PO1, PO2, PO4
6	What are the applications of dual converters?	PO1, PO2, PO4
7	Explain the principle of operation of single phase dual converter with neat power circuit diagram.	PO1, PO2, PO4
8	A half controlled 3- phase bridge rectifier is supplied at 220V from a source of reactance 0.24Ω/phase. Neglecting resistance and device volt drops determine mean load voltage for level load current of 40A at a firing delay angle of 45° and 90°	PO1, PO2, PO4
9	Describe the effect of source inductance on the performance of a single phase full converter indicating clearly the conduction of various thyristors during one cycle	PO1, PO2, PO4
10	Explain the working of a three phase full converter with R- load	PO1, PO2, PO4
<b>Question No.</b>	<b>Questions</b>	<b>PO Attainment</b>

**UNIT – 3: CHOPPERS****PART-A (Two Marks Questions)**

1	What is meant by dc chopper	PO1
2	What are the applications of dc chopper?	PO1
3	What are the advantages of dc chopper?	PO1
4	What is meant by step-up and step-down chopper	PO1
5	What is meant by duty-cycle?	PO1
6	What are the two control strategies in chopper	PO1
7	What are the two types of TRC?	PO1
8	What is meant by PWM control in dc chopper	PO1
9	Write down the expression for the average output voltage for step down and step up chopper	PO1
10	What are the different types of chopper with respect to commutation process?	PO1
11	What is meant by voltage commutation?	PO1, PO2
12	What is meant by current commutation?	PO1
13	Define load commutation?	PO1, PO2
14	What are the advantages of load commutated chopper	PO1, PO2
15	Brief up the working of four quadrant dc chopper	PO1
16	What is current limit control	PO1
17	What is two quadrant chopper	PO1
18	Differentiate between constant frequency and variable frequency control	PO1
19	What is the need for resonant converter?	PO1
20	What are the disadvantages of load commutated chopper?.	PO, PO2

**PART-B (Ten Marks Questions)**

1	Discuss the principle of operation of DC-DC step up chopper with suitable waveform. Derive an expression for its average DC output voltage	PO1, PO2, PO4
2	A step-up chopper has input voltage of 220V? And output voltage of 660V. If the non-conducting time of thyristor chopper is 100 $\mu$ s, compute the pulse width of output voltage. Incase pulse width is halved for constant frequency operation& find the new output voltage.	PO1, PO2, PO4
3	Explain the operation of a step-down chopper with a resistive load. Derive the output voltage waveform and explain the effect of duty cycle on the output voltage	PO1, PO2, PO4
4	Explain the operation of a step-up chopper with an RL load. Derive the output voltage waveform and explain the effect of load inductance on the output voltage.	PO1, PO2, PO4
5	What are the different types of choppers	PO1, PO2, PO4
6	Describe the operation of Class-E chopper with a neat diagrams	PO1, PO2, PO4
7	Discuss the applications of choppers	PO1, PO2, PO4
8	Enumerate the working of Morgan chopper with a neat diagram	PO1, PO2, PO4
9	Discuss the working of a DC Jones Chopper with relevant current and voltage waveforms	PO1, PO2, PO4
10	Explain the working of AC chopper with a neat diagram	PO1, PO2, PO4



Question No.	Questions	PO Attainment
<b>UNIT – 4: INVERTERS</b>		
<b>PART-A (Two Marks Questions)</b>		
1	What is meant by inverter	PO1
2	What are the applications of an inverter	PO1
3	What is the main classification of inverter?	PO1
4	Why thyristors are not preferred for inverters	PO1, PO2
5	What is the main drawback of a single phase half bridge inverter	PO1, PO2
6	Why diodes should be connected in ant parallel with the thyristors in inverter circuits?	PO1, PO2
7	What is meant a series inverter?	PO1, PO2
8	What are the applications of a series inverter?	PO1, PO2
9	What is meant a parallel inverter?	PO1
10	What is meant by McMurray inverter?	PO1
11	What are the applications of a CSI?	PO1
12	How is the inverter circuit classified based on commutation circuitry?	PO1
13	Define the term inverter gain.	PO1
14	Which types of inverters require feedback diodes?	PO1
15	What are the merits and demerits of CSI?	PO1
16	How output frequency is varied in case of a thyristor?	PO1
17	What is the main classification of inverter?	PO1
18	What is meant by forced commutation?	PO1
19	What is meant by commutation	PO1
20	What is meant by natural commutation?	PO1, PO2
<b>PART-B (Ten Marks Questions)</b>		
1	Explain the operation of McMurray-Bedford Half-bridge inverter and also draw it's relevant waveforms	PO1, PO2, PO4
2	Explain Voltage Source Inverter using 180° conduction mode with relevant waveforms	PO1, PO2, PO4
3	With a neat circuit and relevant waveforms discuss the operation of an ideal single phase CSI	PO1, PO2, PO4
4	Discuss the different modes of operation of series resonant inverter with unidirectional switch with neat circuit diagram and waveforms.	PO1, PO2, PO4
5	Describe the working of a 1-Φ full bridge inverter with relevant circuit and waveforms	PO1, PO2, PO4
6	What is PWM? List the various PWM techniques and explain any one of them	PO1, PO2, PO4
7	Describe the operation of three phase voltage source inverter with, 120° mode of operation.	PO1, PO2, PO3
8	Explain the operation of McMurray inverter and also draw it's relevant waveforms	PO1, PO2, PO4
9	Explain the operation of McMurray-Bedford full-bridge inverter and also draw it's relevant waveforms	PO1, PO2
10	Explain the sinusoidal PWM techniques used in inverter.	PO1, PO2



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<b>UNIT – 5: AC VOLTAGE CONTROLLERS AND CYCLO CONVERTERS</b>		
<b><u>PART-A (Two Marks Questions)</u></b>		
1	What is meant by unidirectional or half-wave ac voltage controller	PO1, PO2
2	What are the types of ac voltage controller	PO1, PO2
3	What is meant by bidirectional or half-wave ac voltage controller?	PO1, PO2
4	Write the output rms voltage for 1- $\Phi$ ac voltage controller with RL load	PO1, PO2
5	What are the two methods of control in ac voltage controllers	PO1
6	What are the disadvantages of ac voltage controllers	PO1, PO2
7	What are the advantages of ac voltage controllers?	PO1
8	What are the applications of ac voltage controllers	PO1
9	What is a cycloconverter	PO1
10	What are the different types of cycloconverters?	PO1
11	What are the two types of cyclo converters	PO1
12	What is meant by step-up cyclo converters	PO1
13	What are the applications of cyclo converter?	PO1
14	What is meant by positive converter group in a cyclo converter?	PO1
15	What is meant by negative converter group in a cyclo converter?	PO1
16	What is the difference between an AC voltage controller and a cycloconverter?	PO1
<b><u>PART-B (Ten Marks Questions)</u></b>		
1	Explain the operation of ,1- $\Phi$ AC voltage controller with RL load	PO1, PO2, PO4
2	A, 1- $\Phi$ sinusoidal AC voltage controller has input voltage 230V, 50Hz and a load of 10 ohm. If firing angle of thyristor is 110°. Find i) rms output voltage ii) input PF iii) avg and rms thyristor current	PO1, PO2, PO4
3	Describe the operation of single phase ac voltage controller with the help of voltage and current waveform. Also derive the expression for average value of the output voltage.	PO1, PO2, PO4
4	Explain the working of TRIAC	PO1, PO2, PO4
5	Draw and explain the V-I Characteristics of TRIAC	PO1, PO2, PO4
6	Sketch the power circuit diagram and its relevant waveforms of a 1- $\phi$ full-wave AC voltage controller with RL-loads.	PO1, PO2, PO4
7	An ac voltage controller uses a TRIAC for phase angle control of a resistive load of 100 $\Omega$ . Calculate the value of delay angle for having an rms load voltage of 220 volts. Also calculate the rms value of TRIAC current. Assume the rms supply voltage to be 230V.	PO1, PO2, PO4
8	Explain the operation of 1- $\phi$ to 1- $\phi$ step up cyclo converter with power circuit and waveforms	PO1, PO2, PO4
9	In a standard A single-phase bridge-type cyclo-converter has input voltage of 230V, 50Hz and load of R=10 $\Omega$ . Output frequency is one-third of input frequency. For a firing angle delay of 30°, Calculate (i) rms value of output voltage (ii) rms current of	PO1, PO2, PO4





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	each converter (iii) rms current of each thyristor (iv) input power factor.	
10	Describe the basic working principle of a $1-\phi$ cyclo-converter for continuous conduction with $f_o=1/3 f_s$ and also sketch the wave forms	PO1, PO2, PO4