

III B. Tech I Semester Regular Examinations, Dec/Jan – 2022-23
POWER ELECTRONICS

(Electrical and Electronics Engineering)

Time: 3 hours

Max. Marks: 70

Answer any **FIVE** Questions **ONE** Question from **Each unit**

All Questions Carry Equal Marks

UNIT-I

1. a) With neat layout, explain the two transistor analogy of SCR. [7M]
 b) List and explain the various turn on methods of SCR. [7M]
 (OR)
2. a) Draw and explain the static characteristics of Power IGBT. [7M]
 b) What are the components in snubber circuit. Discuss with neat diagram? [7M]

UNIT-II

3. a) With neat diagram and waveforms, explain operation of single phase half-wave controlled converter with R load and derive the necessary equations. [7M]
 b) Derive the output voltage for single phase fully controlled bridge converter. Draw the voltage and current waveforms. [7M]
 (OR)
4. a) Discuss the operation of single phase semi converter with RLE load with neat circuit diagram with continuous mode. [7M]
 b) A DC battery is charged through a resistor using single phase half wave converter. For an AC source voltage of 230 V, 50 Hz, find the value of average charging current for R= 8 Ohm and E =150 V with minimum firing angle. Also find the power dissipated in the resistor. [7M]

UNIT-III

5. a) With a neat circuit and waveforms, explain the operation three phase half wave rectifier with RL load and derive the expression for average output voltage. [7M]
 b) Discuss about harmonic analysis of three phase semi converter. [7M]
 (OR)
6. a) Explain the operation of a single phase to single phase bridge type cyclo converter to step-down the output frequency for R load. [7M]
 b) With a neat circuit and waveforms, discuss the operation of AC voltage controller with RL load. And derive the expression for rms output voltage. [7M]

UNIT-IV

7. a) Explain the operating principle of Boost chopper with a suitable diagram. Draw the voltage and current waveforms of chopper. [7M]
 b) Consider a buck converter with following circuit parameters: [7M]
 $V_{in}=20$ V, $V_o=15$ V and $I_o= 5$ A, for $f= 50$ kHz. Determine (a) duty cycle (b) L_{cri} (c) maximum and minimum inductor current for $L= 750$ μ H and (d) capacitor voltage ripple for $C= 0.47$ μ F.

(OR)

1 of 2



8. a) Sketch output voltage, output current, source current, thyristor current waveforms for Buck-Boost chopper for its operation. Indicate the conditions of various devices, for ripple free current and explain. [7M]
- b) For the ideal step- down chopper circuit, following conditions are given, $V_s = 220$ V, chopping frequency is 600 Hz, chopping period is 2000 μ s and $R = 1$ Ohm, $L=5$ mH and $E_b=24$ V, Now compute: (i) whether load current is continuous or not (ii) average value of output current [7M]

UNIT-V

9. a) A single phase Full bridge inverter is connected to an RL load. For a DC source voltage of V_s and output frequency, derive load current as a function of time for first two half cycles of output voltage. [7M]
- b) With neat circuit layout, discuss the operation of current source inverter. [7M]
- (OR)
10. a) Explain the operation of three phase inverter operating with 180° mode conduction. Plot the necessary phase and line voltages. List the advantages and disadvantages with this mode of operation. [7M]
- b) Explain the various methods of PWM voltage control of an Inverter. [7M]



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UNIT-I

1. a) What is commutation? List the various methods to turn-off the SCR. Explain any one method in detail. [7M]
 - b) Explain the gate driving circuits of Power IGBT. [7M]
- (OR)
2. a) Explain the I-V characteristics of an SCR with a neat diagram. [7M]
 - b) Draw and explain the dynamic characteristics of Power MOSFET. [7M]

UNIT-II

3. a) Explain the effect of source inductance on the performance of single phase fully controlled bridge rectifier. [7M]
 - b) A single phase full converter supplies a load consisting of R, L and E. The inductance is large and output current is constant. Assume the SCR to be ideal with following data: RMS supply voltage = 220 V, load resistance = 0.5 Ohm, output current is 10 A. Determine (i) firing angle if $E = -135V$, ii) which source is supplying power in $E = 135$ iii) draw the load voltage waveform for both cases. [7M]
- (OR)
4. a) Derive the expression for output voltage of single phase semi converter with RL load in CCM and DCM. [7M]
 - b) Discuss the operation of single phase half wave controlled converter with RL load with freewheeling diode. [7M]

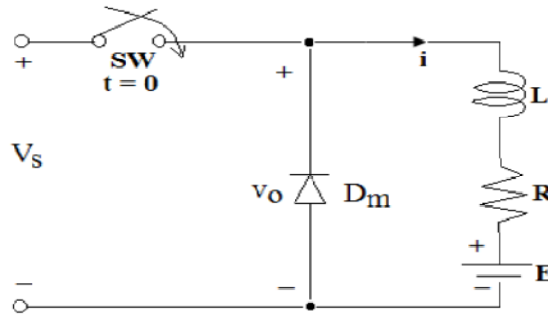
UNIT-III

5. a) Discuss the operation of 3-phase semi converter with R and RL load and draw the voltage wave form for discontinuous and continuous mode of operation? [7M]
 - b) A 3- phase fully controlled bridge converter with 415 V supply, 0.04 Ohm resistance - per phase and 0.25 Ohm reactance per phase is operating in the inverting mode at a firing angle of 135 degrees. Calculate the RMS voltage when the current is 80 A. The thyristor voltage drop is 1.5 V. [7M]
- (OR)
6. a) Derive the expression for circulating current of 3-phase dual converter under on load conditions. [7M]
 - b) Describe the principle operation of single phase bridge type cyclo converter with RL load for discontinuous mode with neat waveforms. [7M]



UNIT-IV

7. a) Explain the operation of a Buck-Boost Chopper circuit with neat waveforms. [7M]
 b) A chopper is feeding an RL load as shown in Figure with $V_s = 220\text{V}$, $R = 5\Omega$, $L=7.5\text{mH}$, $f = 1\text{kHz}$, $k = 0.5$, and $E = 0\text{ V}$. Calculate (i) The minimum instantaneous load current (ii) The peak instantaneous load current (iii) The maximum peak-to-peak load ripple current (iv) The average value of load current. [7M]



(OR)

8. a) Describe the principle of step-up chopper. Derive an expression for the average output voltage in choppers and determine the range of off-periods for the gate signal if step-up chopper has output voltage of two to four times the input voltage, for chopping frequency of 2 KHz. [7M]
 b) For the ideal step- down chopper circuit, following conditions are given, $V_s = 100\text{ V}$, chopping frequency is 600 Hz, chopping period is 2000 μsec and $R = 2\text{ Ohm}$, $L= 10\text{ mH}$ and $E_b=24\text{ V}$, Now compute: (i) whether load current is continuous or not (ii) average value of output current [7M]

UNIT-V

9. a) How can phase displacement control be implemented in a single phase full bridge inverter with neat circuit diagram and waveforms? [7M]
 b) With neat circuit, discuss the operation of half bridge inverter with R load. [7M]

(OR)

10. a) Explain the 3-ph inverter 120 degree mode of operation with neat wave forms for both phase and line voltages. [7M]
 b) A single phase full bridge inverter is operated from a 60 V battery and is supplying power to a pure resistive load of 20 Ohm. Determine: i) the fundamental output voltage and the first five harmonics and ii) RMS value by direct integration method and harmonic summation method. iii) Output rms power and output fundamental power. [7M]



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UNIT-I

1. a) Snubber circuit for an SCR should primarily consist of capacitor only. But, in actual practice, a resistor is used in series with the capacitor. Discuss. [7M]
 - b) A thyristor is controlling the load of resistance R_L . The supply voltage is 240 V DC and the specific limits for di/dt and dv/dt for the SCR are 50 A/ μ sec and 300 V/ μ sec respectively. Determine the values of the di/dt inductance and the snubber circuit parameters R_s and C_s (Take damping ratio is 0.6). [7M]
- (OR)
2. a) Sketch the dynamic characteristics of a thyristor. Discuss briefly the nature of the curves. [7M]
 - b) Discuss the features of R & RC firing circuits of SCR. [7M]

UNIT-II

3. a) Discuss the working of a single phase full converter with R load. Illustrate with waveforms for source voltage, load voltage and current, source current and voltage across on SCR. Assume continuous condition. [7M]
 - b) A single phase 230 V, 1 kW heater is connected across single phase, 230 V, 50 Hz supply through an SCR. For firing angle delays of 45° and 90° . Calculate the power absorbed in the heater element. [7M]
- (OR)
4. a) A single phase semi converter feeds power to RLE load. For discontinuous load current, draw the source voltage, output voltage, load current, source current and freewheeling diode current waveforms as a function of time when: [7M]
 - (i). Extinction angle $\beta > \pi$
 - (ii). Extinction angle $\beta < \pi$ with $V_m \sin \beta < E$
 Explain how various waveforms are obtained and discuss their nature.
 - b) Derive an expression for its output voltage in terms of supply voltage, source inductance load current etc. for the effect of source inductance on single phase full converter. [7M]

UNIT-III

5. a) Discuss the operation of three phase dual converter with circulating current. Draw the voltage waveforms across each converter and load currents. [7M]
- b) A three phase full converter, fed from three phase, 400 V source, has an output voltage of 450 V DC for a firing angle delay of 30° . Calculate the overlap angle and the voltage drop due to overlap. [7M]

(OR)

1 of 2



6. a) For a three phase full converter, explain how output voltage wave, [7M]
for a firing angle of 30° , is obtained by using (a) phase voltage, (b)
line voltage
- b) What is the load angle effect on choosing firing angle in AC voltage [7M]
controller with RL load? What types of firing pulses are used?

UNIT-IV

7. a) What is meant by step up chopper? Explain its operation. Sketch [7M]
the input voltage, input current, output voltage and output current
waveforms. State the various assumptions made.
- b) What is current limit control? How does it differ from TRC? Which [7M]
of these control strategies is preferred over the other and why?
- (OR)
8. a) In the continuous conduction mode of step down chopper, show [7M]
that per unit ripple in the load current is maximum when duty
cycle is equal to 0.5.
- b) A step down chopper is fed from 230 V DC and its duty cycle is 0.5. [7M]
Calculate rms value of output voltage.

UNIT-V

9. a) Discuss the operation of bipolar switching of single phase full [7M]
bridge inverter with neat diagram and waveforms.
- b) Describe sinusoidal PWM technique as used in a single phase full [7M]
bridge inverter by sketching various waveforms.
- (OR)
10. a) For a three phase 180° mode bridge inverter feeding a star [7M]
connected resistive load, sketch line to neutral voltage waveforms.
From this sketch, calculate the rms value of phase voltage. Source
voltage is V_s .
- b) Consider half-bridge inverter with the following circuit components: [7M]
 $V_{dc}=40$ V, $R= 8$ Ohm, $f=400$ Hz and $L=40$ mH. (i) derive the exact
expression of $i_L(t)$ (ii) derive the expression for the fundamental
components of $i_L(t)$ and (iii) determine the average diode and
thyristor currents



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UNIT-I

1. a) List and explain the various turn on methods of SCR. [7M]
 b) With neat circuit diagram and waveforms explain Synchronised UJT triggering circuit. [7M]

(OR)

2. a) Sketch the dynamic characteristics of a thyristor. Discuss briefly the nature of the curves. [7M]
 b) With a neat circuit, discuss the gate driving circuit of Power IGBT. [7M]

UNIT-II

3. a) Discuss the harmonic analysis of single phase full bridge converter and derive the necessary expressions. [7M]
 b) Explain the effect of source inductance in single phase fully controlled bridge rectifier. [7M]

(OR)

4. a) With neat diagram Explain about single phase fully controlled bridge converter with RL load. [7M]
 b) A single phase 230 V, 2 kW heater is connected across single phase, 230 V, 50 Hz supply through an SCR. For firing angle delays of 30° and 60° . Calculate the power absorbed in the heater element. [7M]

UNIT-III

5. a) Discuss the operation of three phase dual converter with circulating current. Draw the voltage waveforms across each converter and load currents. [7M]
 b) A 3- phase fully controlled bridge converter has a load of $R= 2.5$ Ohm, $L= 1.5$ mH and $E= 10$ V. The line-to-line voltage is 220 V, 50 Hz. Determine (i) the steady state load current at $\omega t=\pi/3$ (ii) average diode current (iii) rms diode current and (iv) rms output current. [7M]

(OR)

6. a) Describe the principle operation of single phase midpoint cycloconverter with RL load for discontinuous mode with neat waveforms. [7M]
 b) Discuss the operation of AC Voltage controller for R load with neat circuit and waveforms. [7M]

UNIT-IV

7. a) Design a buck converter operating in CCM with the following specifications: $(\Delta V_o)/V_o=0.5\%$, $V_{in}=20$ V, $P_o= 12$ W, $f= 30$ kHz and $D= 0.4$. [7M]



- b) What is meant by step up chopper? Explain its operation. Sketch the input voltage, input current, output voltage and output current waveforms. State the various assumptions made. [7M]
(OR)
8. a) Consider a buck-boost converter that supplies 75 W at $I_o=5$ A from a 37 V DC source. Let $T=130 \mu\text{s}$ and $L=250 \mu\text{H}$. Determine (i) duty ratio (ii) $I_{L\text{max}}$ and $I_{L\text{min}}$ (iii) average input current and (iv) average diode and thyristor currents. [7M]
b) Explain the operating principle of Boost chopper with a suitable diagram in CCM and DCM. Draw the voltage and current waveforms of chopper. [7M]
- UNIT-V**
9. a) For a three phase 180° mode bridge inverter feeding a star connected resistive load, sketch line to neutral voltage waveforms. From this sketch, calculate the rms value of phase voltage. Source voltage is V_s . [7M]
b) A single phase full bridge inverter is operated from a 48 V battery and is supplying power to a pure resistive load of 10 ohm. Determine: i) the fundamental output voltage and the first five harmonics. ii) RMS value by direct integration method and harmonic summation method. iii) Output rms power and output fundamental power. [7M]
(OR)
10. a) Single phase half-bridge inverter has a resistance load of 30 Ohm and DC input voltage 50 V. Calculate (i) rms output voltage (ii) output power (iii) average and peak currents of each thyristor and (iv) peak inverse blocking voltage of each thyristor. [7M]
b) Discuss the operation of PWM with unipolar voltage switching of single phase full bridge inverter with neat circuit and waveforms. [7M]

