Code No: R2031022 **R20** SET - 1

III B. Tech I Semester Regular/Supplementary Examinations, December -2023
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
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UNIT-I

1. a) Describe the different modes of operation of a thyristor with the help of its static I-V characteristics. [7M]
   b) For resistance firing circuit, show that the firing delay angle is proportional to the variable resistance. [7M]

(OR)

2. a) Describe the two-transistor model of a thyristor. Derive an expression for the anode current and discuss the turn on mechanism of thyristor. [7M]
   b) Describe the gate triggering of a thyristor. Does the gate current has any effect on the forward break over voltage? Discuss. [7M]

UNIT-II

3. a) Explain the operation of single phase full-wave controlled bridge rectifier with R-L load under continuous mode of operation. Draw the wave forms of output voltage, voltage across SCR and average load current for $\alpha = 60^0$. [7M]
   b) A single phase fully controlled bridge converter is supplied from 230 V, 50 Hz ac supply and it is fed to load consisting of R = 10 Ω and large inductance such that load current is constant. When the firing angle is 45^0, i) calculate average and rms current ii) if the source inductance of 1.5 mH is connected find the average voltage and overlap angle at the same firing angle. [7M]

(OR)

4. Describe the effect of source inductance on the performance of a 1-phase full converter with the help of phase voltage waveforms. Indicate the sequence of conduction of various thyristors tors and sketch load current waveforms for both positive and negative group of thyristors. State the various assumptions made. Derive an expression for its output voltage in terms of supply voltage, source inductance, load current etc. [14 M]

UNIT-III

5. a) For a 3-phase full converter, explain how output voltage wave, for a firing angle of 30^0,isobtained by using(i) phase voltages and (ii) line voltages. [7M]
   b) A resistive load of 10 Ω is connected to a 3-phase full converter. The load takes 5 kW for a firing angle delay of70^0.Find the magnitude of per phase input supply voltage. Derive the expression required for the output voltage in terms of firing angle etc. [7M]

(OR)

6. a) Discuss the operation of a single-phase AC regulator with RL load when α is less than, or equal to, load phase angle θ. Hence show that for α less than θ, output voltage of the AC regulator cannot be regulated. [7M]
   b) Discuss the working of a single-phase bridge type cycloconverter with RL load and for continuous operations with relevant output waveforms and circuit diagram for $f_0 = (1/4) f_s$ [7M]

UNIT-IV

7. a) Explain the operating principle of dc chopper with a suitable diagram. Draw the voltage and current waveforms of chopper. Derive expressions for average output voltage and rms output voltage. [7M]
   b) State the current limit control? Explain the difference between current limit control and time ratio control. Why current limit control is preferred over any other control strategies? [7M]

(OR)

8. With relevant waveforms, explain the analysis of Buck converter in CCM operation. Also derive the expression for Critical inductance and capacitance in terms of specified voltage ripple [14 M]

UNIT-V

9. a) Describe the working of single-phase half bridge inverter with RL Load. What are the major drawbacks. [7M]
   b) What is the need for PWM in inverters. Explain in brief? [7M]

(OR)

10. a) For a three phase 180^0 mode bridge inverter feeding star connected resistive load, sketch the line to neutral voltage waveform for phase 'a' only. From this sketch, calculate the rms value of phase voltage. Source voltage is V_s. [7M]
    b) A single-phase half-bridge inverter has a resistive load of 10 Ω and the center tap dc input voltage is 100 V. Determine (i) rms value of output voltage, (ii) rms value of fundamental component of output voltage, (iii) first three harmonics of the output voltage waveform, (iv) fundamental power consumption in load and (v) rms power consumed by load. [7M]

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UNIT-I

1. a) Define latching and holding currents as applicable to SCR. Show these currents on its static I-V characteristics. [7M]
   b) Compare UJT firing circuit with R & RC firing circuits. [7M]

(OR)

2. a) Write a brief note on different turn-on methods of SCR? [7M]
   b) Describe the static characteristics of Power MOSFET? [7M]

UNIT-II

3. a) Show that the performance of a single-phase full converter as effected by source inductance is given by the relation. [7M]

$$\cos(\alpha+\mu)=\cos\alpha-\frac{\omega L_s I_0}{V_m}$$

   b) A single-phase fully controlled converter with RLE load is supplied from 220 V, 50 Hz ac supply. The average load current is 6 A which is constant over the working range. Determine the firing angle for(i) E = 100 V (ii) E = –100 V. Assume R = 5 Ω and L = 4 mH. [7M]

(OR)

4. a) Describe the working of a single-phase full converter in the inverter-mode with RLE load. Illustrate your answer with waveforms for source voltage, E, load voltage and current, source current, current through and voltage across one 8CR. Assume continuous conduction. [7M]
   b) Draw the circuit diagram of a dual converter and explain the basic operating principle of a dual converter [7M]

UNIT-III

5. a) Explain the working of three phase dual converter in circulating current mode? [7M]
   b) Explain the principle of operation of step up cycloconverter with relevant waveforms. [7M]

(OR)

6. a) Describe the principle of phase control in single-phase half-wave ac voltage-controller. Derive expressions for the average and rms value of output voltage for this voltage controller. [7M]
   b) Discuss the working of a single-phase bridge type cycloconverter with RL load and for continuous operations with relevant output waveforms and circuit diagram for $f_0=(1/3)f_s$ [7M]

UNIT-IV

7. a) Derive the expression for output Voltage of buck-boost converter using vol-sec balance in CCM of operation. Also derive the expression for critical inductance. [7M]

|'''|'|'|''||'''||||

b) The boost converter has parameter Vs = 20 V, D = 0.6, R = 12.5 Ω,L =10μH, C = 40 μF, and the switching frequency is 200 kHz. (i) Determine the output voltage. (ii) Determine the average, maximum, and minimum inductor currents. (iii)Determine the output voltage ripple. (iv) Determine the average current in the diode. Assume ideal components. [7M]

(OR)

8. a) With relevant waveforms, explain the analysis of Buck converter in DCM operation. [7M]

b) A step-down chopper has a load resistance of 20 W and input dc voltage is 200 V. When the chopper switch is ON, the voltage across semiconductor switch is 2 V. If the chopping frequency is 1.5 kHz andduty ratio is 40%, determine (i) average dc output voltage, (ii) rms output voltage and (iii) efficiency of chopper. [7M]

UNIT-V

9. a) Describe the working of single-phase full bridge inverter with R Load with relevant waveforms. [7M]

b) What is pulse width modulation? List the various PWM techniques. How do these differ from each other? [7M]

(OR)

10. What is the need for controlling the voltage at the output terminals of an inverter? Describe briefly and compare the various methods employed for control of output voltage of inverters. [14M]

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UNIT-I

1. a) What is snubber circuit? Explain the design procedure of a snubber circuit. [7M]
   b) When a SCR is operating with a peak supply voltage of $230\sqrt{2}$ V and it has the following parameters: [7M]

   Repetitive peak current: $I_p = 100A, \left.\frac{dv}{dt}\right|_{\max} = 400 V/\mu s, \left.\frac{di}{dt}\right|_{\max} = 80 A/\mu s$

   Design a snubber circuit for SCR protection. Assume the factor of safety is 2.5 and the minimum value of resistance is 25 Ω.

(OR)

2. a) Explain the switching characteristics of SCR during turn-on process. [7M]
   b) Write short notes on the following:(i) UJT triggering circuit(ii) R triggering circuit. [7M]

UNIT-II

3. a) With relevant waveforms, explain the working of single-phase semi converter with RL load. Derive the expression for average output voltage. [7M]
   b) A single -phase full converter, connected to 230 V, 50 Hz source, is feeding a Load R = 10 Ω in series with a large inductance that makes the load current ripple free. For a firing angle of 45^0, calculate average output power, current and input power factor. [7M]

(OR)

4. Describe the working of a single-phase full converter in the rectifier and inverter modes with RLE load. Discuss how one pair of SCRs is commutated by an incoming pair of SCRs. Illustrate your answer with waveforms for source voltage, E, output voltage and current, source current, current through and voltage across one thyristor. Assume continuous conduction. Derive an expression for the average output voltage in terms of source voltage and firing angle. [14M]

UNIT-III

5. a) Describe the operation of three phase full converter feeding an RL load and draw the wave forms for any firing angle which is more than the 45^0. [7M]
   b) A three –phase full converter is connected to a load resistance of 5 Ω and it is supplied from a 220 V, 50 Hz ac supply, If the firing angle of thyristor is $\alpha = 60^o$, Draw the relevant waveforms and determine i) average output voltage, ii) average output current, iii) rms output voltage and iv) rms output current. [7M]

(OR)

|'''|'|'|''||'''||||

6. a) Discuss the principle of phase control in single-phase full-wave ac voltage controller. Derive an expression for the rms value of its output voltage. [7M]
   b) A single-phase ac voltage controller is employed for controlling the power flow from 230 V, 50 Hz source into a load circuit consisting of R = 4 Ω and ωL=3 Ω. Calculate: i) the control range of Firing angle; ii) the maximum power delivered to load and power factor; iii) the maximum values of average and rms SCR currents. [7M]

UNIT-IV

7. With relevant waveforms, explain the analysis of Boost converter in CCM operation. Also derive the expression for Critical inductance and capacitance in terms of specified voltage ripple. [14 M]

(OR)

8. a) What is the current limit control? How does it differ from TRC? Which of these control strategies are preferred over the other. Why? [7M]
   b) A step-up chopper has an input voltage of 200 V and output voltage of 400 V. If the conduction time of switch is 150 ms, what is pulse width of output voltage? If the pulse width of output voltage become one fourth for constant frequency operation, compute the new average value of output voltage. [7M]

UNIT-V

9. a) Describe the working of single-phase full bridge inverter with RL Load with relevant waveforms. [7M]
   b) Explain the comparison between VSI and CSI. [7M]

(OR)

10. Discuss the working of a three-phase bridge inverter with a suitable diagram. Draw phase and line voltage waveforms on the assumption that, each semiconductor switch conducts for 180° and the resistive load is star connected. [14M]

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UNIT-I

1. a) Enumerate the various mechanisms by which thyristors can be triggered into conduction. [7M]
   b) Describe class-C type of commutation used for thyristors with appropriate current and voltage waveforms. [7M]

(OR)

2. a) Explain the static characteristics of Power IGBT. [7M]
   b) A thyristor is placed between a constant dc voltage source of 240 V and resistive load R. The specified limits for ***di/dt*** and ***dv/dt*** for the SCR are 60 A/μs and 300V/μs respectively. Determine the values of the ***di/dt*** inductor and the snubber circuit parameters. Take damping ratio as 0.5. [7M]
   Discuss how these parameters may be modified to suit the working conditions in the circuit. Derive the various expressions used

UNIT-II

3. a) For a single-phase one-pulse controlled converter system, sketch waveforms for load voltage and load current for (i) RL load and (ii) RL load with freewheeling diode across RL. From comparison of these waveforms, discuss the advantages of using a freewheeling diode. [7M]
   b) List the differences between circulating and non-circulating current mode of operation in dual converters [7M]

(OR)

4. a) Describe the operation of a single-phase two-pulse mid-point converter with relevant voltage and current waveforms. Discuss how each SCR is subjected to a reverse voltage equal to double the supply voltage in case turns ratio from primary to each secondary is unity. [7M]
   b) 100 V battery is charged through a resistor R from a Single-phase half-wave-controlled rectifier with RE load. When the charger circuit is fed from 220 V 50 Hz ac supply and R is 5 Ω, compute (i) the minimum angle at which thyristor wil lbe turned ON, (ii) the angle at which thyristor will be turned OFF, (iii) maximum conduction period of thyristor,(iv) average charging current when $\alpha = 45°$, (v) Power supplied to battery, (vi) Power dissipated in resistor R and(vii) input power factor. [7M]

UNIT-III

5. a) Explain the working of three phase semi-converter with relevant waveforms for a firing angle of 45^0 with R Load and indicate the conduction of its various elements on the assumption of continuous conduction. Derive the expression for average output voltage. [7M]

b) Three-phase half-wave-controlled rectifier is fed from a 3-phase, 440 V, 50 Hz ac supply and it is connected with a R load of 10 W. When the firing angle of thyristor is 20°, calculate (i) dc output voltage, (ii)r.m.s value of output voltage, (iii) average output current, (iv) rms load current, (v) dc output power, [7M]

(OR)

6. Describe the operating principle of single-phase-to-single-phase step-up cycloconverter with the help of mid-point and bridge-type configurations. Illustrate your answer with appropriate circuit and waveforms. The conduction of various thyristors must also be indicated in the waveforms. [14M]

UNIT-IV

7. a) A step-up chopper has an input voltage of 210 V and output voltage of 550 V. (i) If the conduction time of switch is 100 ms, determine the pulse width of output voltage. (ii) If the pulse width of output voltage becomes one half for constant frequency operation, find the new average value of output voltage. [7M]

b) The buck dc-dc converter has the following parameters: [7M]
V_s =50 V, D = 0.4,L = 400 μH,C = 100 μF, f =20 kHz, R = 20 Ω. Assuming ideal components, calculate (i) the output voltage Vo, (ii) the maximum and minimum inductor current, and (iii) the output voltage ripple.

(OR)

8. a) For the boost converter, sketch the inductor and capacitor currents. Also derive the expression for critical inductance. [7M]

b) The buck-boost circuit has these parameters: [7M]
V_s = 24 V, D = 0.4, R = 5 Ω, L = 20 μH, C = 80 μF, f = 100 kHz. Determine the output voltage, inductor current average, maximum and minimum values, and the output voltage ripple

UNIT-V

9. Discuss the working of a three-phase bridge inverter with a suitable diagram and waveforms when each semiconductor switch conducts for 120°. [14M]

(OR)

10. a) Describe the working of single-phase half bridge inverter with R Load with relevant waveforms. [7M]

b) Write short notes on the following: (i) Single pulse width modulation (SPWM) (ii) Sinusoidal Pulse Width Modulation (Sine PWM) [7M]