

Code No: V3112

R07**Set No: 1**

III B.Tech. I Semester Supplementary Examinations, November/December - 2012

POWER ELECTRONICS

(Electrical and Electronics Engineering)

Time: 3 Hours**Max Marks: 80**

Answer any FIVE Questions

All Questions carry equal marks

- 1 (a) Discuss basic theory of operation of SCR with its static characteristics.
(b) An SCR has a V_g-I_g characteristics given as $V_g=1.5+8I_g$. In a certain application the gate voltage consists of rectangular pulses of 12V and of duration 50 μ s with duty cycle 0.2.
(i) Find the value of R_g series resistor in gate circuit to limit the peak power dissipation in the gate to 5 watts.
(ii) Calculate average power dissipation in the gate
- 2 (a) Derive an expression for the anode current of two transistor model of a thyristor.
(b) Calculate the number of SCRs, each with rating of 500V, 75A required in each branch of a series and parallel combination for a circuit with the total voltage and current rating of 7.5kV and 100A. Assume derating factor of 14%.
- 3 (a) Explain the principle of operation of single phase half wave controlled bridge rectifier with RL load and also derive output voltage and current expressions.
(b) A single phase transformer, with secondary voltage of 230V, 50Hz, delivers power to load $R=15\Omega$ through a half-wave controlled rectifier circuit. For a firing angle delay of 30° , determine (i) the rectification efficiency (ii) form factor (iii) voltage ripple factor (iv) transformer utilization factor and (v) PIV of thyristor.
- 4 (a) Explain the principle of operation of single phase full Converter converter with R load and derive voltage and current expressions.
(b) A single phase full-wave mid-point converter with freewheeling diode is supplied from a 120V, 50Hz supply with a source inductance of 0.33mH. Assuming the load-current is continuous at 4A, find the overlap angles for
(i) transfer of current from a conducting thyristor to the commutating diode
(ii) from the commutating diode to a thyristor when the firing angle is 15°

Code No: V3112

R07**Set No: 1**

- 5 (a) Describe the principle of operation of three phase fully controlled bridge converter with resistive load.
(b) Derive output voltage by considering an effect of source inductance in case of three phase fully controlled Bridge converter.
- 6 (a) Explain different triggering modes of Triac.
(b) A single phase a.c. regulator feeds power to a resistive load of 4Ω from 230V, 50Hz source. Determine
(i) the ratio of third harmonic voltage to fundamental voltage for $\alpha=60^\circ$
(ii) the maximum value of di/dt occurring in the SCRs.
- 7 (a) Explain the principle of operation of Morgan's chopper with associated waveforms.
(b) A step up chopper is used to deliver load voltage of 500V from a 220V d.c. source. If the blocking period of the thyristor is $80\mu s$, compute required pulse width.
- 8 (a) Explain the different modes of operation of basic parallel inverter.
(b) The single phase modified McMurray full-bridge inverter is fed by a d.c. source of 300V. The d.c. source voltage may fluctuate by $\pm 15\%$ The current during commutation may vary from 20A to 100A. Obtain the value of the commutating components if the thyristor turn-off time is $20\mu s$. Also determine the value of R.

Code No: V3112**R07****Set No: 2**

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- (a) Explain the dynamic characteristics of an SCR

(b) Discuss steady state characteristics of BJT with neat sketches.
- (a) Discuss methods for ensuring proper current sharing in case of parallel operation of thyristors.

(b) A 100A SCR is to be used in parallel with a 150A SCR. The on-state voltage drops of the SCRs are 2.1 and 1.75V respectively. Calculate the series resistance that should be connected with each SCR if two SCRs have to share the total current 250A in proportion to their ratings.
- (a) Explain principle of operation of single phase half controlled bridge Rectifier with R load and also derive output voltage and current expressions.

(b) A single phase semi-converter delivers power to RLE load with $R=10$ ohms, $L=15$ mH and $E=60$ V. The ac source voltage is 230V, 50Hz. For continuous conduction, find the average value of output current for a firing angle delay of 30deg.
- (a) Explain the principle of operation of single phase two pulse mid-point converter with R load using relevant voltage and current waveforms.

(b) A highly inductive load, such that load current can be assumed constant is to be supplied from a 230V, 50Hz, single phase supply by a fully-controlled and a half controlled bridges. Compare the average load voltage provided by each bridge at firing angle of 30° and 90° . Neglect device voltage drops.
- (a) Explain the principle of operation of three phase dual converters.

(b) A three phase fully controlled bridge converter is connected to 415V supply, having a reactance 0.3Ω /phase and resistance of 0.05Ω /phase. The converter is working in the inversion mode at a firing advance angle of 35° . Compute the average generator voltage. Assume $I_d=60$ A and thyristor drop= 1.5 V.

Code No: V3112

R07

Set No: 2

6. (a) Discuss the principle of operation of single phase to single cycloconverter with centre tapped transformer configuration.
(b) A single phase a.c. voltage regulator with R-L load has the following details.
Supply voltage = 230V, 50Hz, $R=4\Omega$ and $\omega L=3\Omega$. Calculate:
(i) the control range of firing angle
(ii) the maximum value of RMS load current
7. (a) Discuss control strategies for chopper circuits.
(b) An RLE_b type load in a chopper circuit is fed from a 400V d.c. source. The load parameters are $L=0.05H$ and $R=0$. For a duty cycle of 0.3, find the chopping frequency to limit the amplitude of load current excursion to 8A.
8. (a) Discuss the different modes of operation of Mc Murray inverter.
(b) A single phase full bridge inverter has a resistive load of $R=3\Omega$ and the d.c. input voltage $E_{dc}=50V$. Calculate
(i) the RMS output voltage at the fundamental frequency E_1
(ii) the output power, P_0
(iii) the average and peak current of each thyristor.

Code No: V3112

R07**Set No: 3**

III B.Tech. I Semester Supplementary Examinations, November/December - 2012

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1. (a) Explain static i-v characteristics and gate characteristics of an IGBT with neat sketches
(b) Discuss basic structure of an IGBT.
2. (a) Discuss static equalizing and dynamic equalizing network in case of series and parallel connected SCRs
(b) A thyristor string is formed by the series and parallel connection of thyristors. The voltage and current ratings of the string are 6kV and 4kA respectively. Available thyristor have the voltage and current ratings of 1.2kV and 1 kA respectively. The string efficiency is 90% for both the series and parallel. If the maximum blocking current is 15mA and $\Delta Q_{\max}=25\mu\text{C}$, calculate the values of R and C.
3. (a) Explain the principle of operation of single phase half wave circuit with RLE load with the help of neat sketches.
(b) A single phase 230V, 1kW heater is connected across single phase 230V, 50Hz supply through an SCR. For firing angle delay of 45° and 90° .
4. (a) Derive a general expression for the average load voltage of P-pulse fully-controlled converter. Also determine the RMS value of current that flows for $1/p$ of each cycle.
(b) A single phase full converter is made to deliver a constant load current. For zero degree firing angle, the overlap angle is 10° . Calculate the overlap angle when firing angle is (i) 30° (ii) 45° and (iii) 60° .
5. (a) Explain the principle of operation of 3 phase full converter with R-load using neat sketches and also derive the output voltage and current expressions.
(b) A three phase fully controlled converter charges a battery from a three-phase supply of 230V, 50Hz. The battery emf is 200V and its internal resistance is 0.5Ω . On account of inductance connected in series with battery charging current is constant at 20A. Calculate (i) firing angle (ii) supply power factor.

Code No: V3112

R07**Set No: 3**

6. (a) Explain the principle of operation of single phase full-wave a.c. voltage controller with R load.
(b) Discuss the advantages and disadvantages of Triac over an SCR.
7. (a) Explain principle of operation of Jones chopper with neat sketches.
(b) A simple d.c chopper is operating at a frequency of 2kHz from a 96V d.c. source to a supply a load resistance of 8Ω . The load time constant is 6ms. If the average load voltage is 57.6V, find the T_{on} period of the chopper, the average load current, the magnitude of the ripple current and its RMS value.
8. (a) Discuss the different modes of operation of Mc Murray Bedford inverter.
(b) Design a series inverter circuit for operation in the frequency range of 1 to 5kHz. The load resistance may vary from 25Ω to 100Ω . The peak load current is limited to 3A and the supply voltage is 100V.

Code No: V3112

R07**Set No: 4**

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POWER ELECTRONICS

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- Explain the different modes of operation of a thyristor.
 - Describe the turn on and turn off times of an SCR.
- Explain different modes of operation of Class-D commutation circuit.
 - Two SCRs are connected in parallel. One SCR has an approximate characteristics of $V = [0.9 + (2.4 \times 10^{-4} i)] V$, and the other SCR $V = [1.0 + (2.3 \times 10^{-4} i)] V$. Determine the current taken by each SCR if the total current is (i) 500A (ii) 1000A (iii) 1500A (iv) 2000A. Determine the value of equal resistors which when placed in series with the SCRs will (iv) bring the SCR current to within 10% of equal current sharing.
- Discuss the principle of operation of freewheeling diode in case of single phase half wave rectifier.
 - A single phase half wave converter is operated from 230V, 50Hz source and the load resistance $R=10\Omega$. For a firing angle delay of 45° , determine (i) the rectification efficiency (ii) form factor (iii) voltage ripple factor (iv) transformer utilization factor.
- Discuss the performance of converter with effect of load and source inductance.
 - A single phase full converter is supplied from 230V, 50Hz source. The load consists of $R=10\Omega$ and a large inductance so as to render the load current constant. For a firing angle delay of 30° , determine (i) fundamental power factor (ii) supply power factor (iii) supply harmonic factor (iv) voltage ripple factor
- Discuss an effect of freewheeling diode in case of three pulse mid-point converter.
 - Three phase fully controlled bridge converter is fed from supply voltage of 230V per phase and frequency of 50Hz. The source inductance is 3mH. The total current on d.c. side is constant at 15A. If the load consists of a d.c. source voltage of 400V having an internal resistance of 1Ω . Determine (i) Firing angle (ii) Overlap angle

Code No: V3112

R07

Set No: 4

6. (a) Explain principle of operation of single phase a.c. voltage controller with RL load. Draw necessary waveforms.
(b) Explain the principle of operation of single phase to single cycloconverter with bridge configuration.
7. (a) Explain the different modes of operation of A.C. chopper with neat sketches.
(b) A d.c. chopper circuit connected to a 100V d.c. source supplies an inductive load having 40mH in series with a resistance of 5Ω . A freewheeling diode is placed across the load. The load current varies between the limits of 10A and 12A. Determine the time ratio of the chopper.
8. (a) Explain principle of operation of single phase basic series inverter with neat sketches.
(b) Discuss the voltage control techniques for inverters.

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