CODE NO: 07A50204 | R07 | SET - 1

III B.TECH - I SEMESTER EXAMINATIONS - MAY, 2011
POWER ELECTRONICS
(ELECTRICAL AND ELECTRONICS ENGINEERING)

Time: 3hours **Max. Marks: 80**

Answer any FIVE questions
All Questions Carry Equal Marks
- - -

1.a) Sketch the dynamic characteristics of SCR during turn-ON process. Write down the necessary conditions required to turn-ON SCR.

b) A thyristor is connected in series with an inductance of 0.1 H and a resistance of 20 ohms and a sinusoidal voltage source of 230 V, 50 Hz. The latching current of SCR is 25 mA. Calculate the minimum width of gate pulse required to ensure reliable triggering if it is gated at an angle of 30^0 in every positive half cycle of supply voltage. [8+8]

2.a) How a thyristor is protected from high values of dv/dt and di/dt. Derive an expression for parameters of the circuit required to protect thyristor from high values of dv/dt.

b) Design a UJT relaxation oscillator circuit for triggering a thyristor. The UJT has the following parameters:
η=0.72, I_p= 60μA , V_v=2.5 V, I_v=4mA, V=15 V, R_{BB}= 5 k ohms
The leakage current with emitter open is 3mA.The triggering frequency is 1kHz and $V_{g(min)}$ of thyristor is 0.3 V. Also calculate the minimum and maximum values of triggering frequency. [8+8]

3.a) What is meant by the term 'phase control'? Draw the circuit of a single phase half controlled bridge rectifier with common anode configuration. Explain the sequence of firing of thyristor to obtain output voltage across R-L load without free wheeling diode. Derive an expression for its output voltage.

b) A single phase half controlled bridge rectifier is connected to a source of 115 V, 50 Hz and a load of 20 ohms. Determine the average load current at firing angle of i) 30 deg ii) 60 deg. [8+8]

4.a) Explain the operation of single phase full wave controlled rectifier feeding an inductive load. Consider the effect of source inductance and derive an expression for output voltage in terms of source inductance and firing angle.

b) A single phase fully controlled rectifier is operated from 120 V, 50 Hz supply. It has a load of having R= 0.5 ohm and inductance of 6.5 mH and E=10 V. The firing angle is 60 deg. Calculate the average load current, average and rms values of thyristor current. [8+8]

5.a) Draw the circuit of 3-phase fully controlled rectifier. Explain how the output voltage can be obtained with the help of the waveform. Derive an expression for the average output voltage.

b) Sketch the output voltage waveform of a single phase dual converter. Derive an expression to determine the amplitude of circulating current when both the bridges are on. [8+8]

6.a) What are steps involved in determining the output voltage waveform for single phase ac voltage controller with two SCRs connected back to back. Assume that the load is highly inductive.

b) A single phase ac voltage controller given in (a) has a resistive load of 10 ohms and the source voltage is 120 V(rms). The delay angles of thyristor are 90 deg each. Determine

i) Rms output voltage

ii) Input power factor

iii) Average current of thyristor. [8+8]

7.a) Discuss the control strategies of dc to dc converters (i) time ration control (ii) Current limit Control. Sketch the waveform of load voltage and current for the above cases.

b) A step down chopper is feeding an R-L load of R=5 ohms, L= 7.5 mH, E=0 V from a source of 220 V (dc) .Calculate the minimum and maximum values of average value of load current. [8+8]

8.a) Explain the operation of single phase bridge inverter with the help of waveform.

b) Why PWM control is implemented in inverter circuits? Explain any two PWM control techniques employed in single phase inverters. [8+8]

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Time: 3hours **Max. Marks: 80**

Answer any FIVE questions
All Questions Carry Equal Marks
- - -

1.a) Sketch static V-I characteristics of SCR. Explain how SCR could be operated as a switch with the help of the characteristics.
b) For an SCR the gate-cathode characteristics are given by a straight line passing through origin with gradient of 16 V/A. The turn-on time is 4 μsec and gate current required is 500 mA. Given the gate source voltage of 15 V, calculate
i) Gate power dissipation
ii) The resistance to be connected in series with gate. [8+8]

2.a) Draw the two transistor analogy of SCR and explain why gate loses control once thyristor is fired when anode current is greater than latching value. (8)
b) Derive an expression for dynamic resistance to be connected across each thyristor in string of *n* number of series connected SCRs. [8+8]

3.a) Derive an expression for average and rms values of output voltage in a single phase half wave controlled rectifier with R-L load.
b) An SCR is connected between a source of $330\ Sin\omega t$ and a load of 10 ohms and a battery with emf of 165 V. When it fired with a continuous dc signal, calculate
i) Average current ii) power supplied to battery iii) power dissipated in resistor. [8+8]

4.a) Explain the operation of full wave controlled rectifier with input supply derived from a single phase transformer with centre tapped secondary.
b) Carry out harmonic analysis of input current in a fully controlled rectifier feeding an R-L load without free wheeling diode. [8+8]

5.a) Explain the operation of a 3-pulse converter fed from 3-phase 4-wire system and derive an expression for its output voltage.
b) A three phase fully controlled bridge is connected to a highly inductive load with a resistance of 60 ohms. Determine average voltage, average load current and input power factor for firing angle of 30 deg. The input supply voltage is 400 V, 50 Hz. Assume load current to be ripple free. [8+8]

6.a) Draw the circuit diagram of ac voltage controller with two thyristors connected back to back. Obtain its output voltage waveform.
b) A single phase controller operating from 230 V, 50 Hz supply uses integral cycle control to control the flow of power to 10 ohms load. The thyristors conduct for 18 cycles and remain off for 32cycles. Find i) rms value of output voltage
ii) power output to the load iii) input power factor iv) average thyristor current. [8+8]

7.a) Explain the operation of a dc – dc converter with a load commutation circuit. Sketch the waveforms of current, voltage across thyristor, load voltage.

b) A step down chopper is connected to a resistive load of 10 ohms. The ON time and OFF time of the chopper are 200 μsec and 300 μsec repectively. Determine the average output voltage, power consumed by load. [8+8]

8.a) Why is it not possible to obtain pure sine wave output from a single phase bridge inverter? Derive an expression for its output voltage in terms of harmonic components.

b) Calculate the output frequency of series inverter with the following components: L= 6mH, C= 1.2 μF, load resistance = 100 ohms, Take T_{off}= 0.2 msec. Also find the range of output frequency if the load is changed from 40 ohms to 140 Ohms. [8+8]

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Time: 3hours **Max. Marks: 80**

Answer any FIVE questions
All Questions Carry Equal Marks
- - -

1.a) A BJT is acting as a switch, the forward current gain β is in the range 8 to 40. The load resistance is R_C = 11Ω. The dc supply voltage is V_{CC}=200v and the input voltage to the base circuit is V_B=10v. Find
a) The value of R_B that results in saturation with an over drive factor of 5.
b) The β forced
c) The power loss P_T in the transistor.
b) What are the various applications of an IGBT? [8+8]

2.a) Compare a BJT, MOSFET, IGBT with respect to the following:
a) Basel Gate control variable
b) Control characteristic
c) Switching frequency
d) On-stage voltage drop
e) Max voltage rating
f) Max current rating.
b) Write down the advantages and limitations of BJT and MOSFET. [8+8]

3.a) Explain the features of phase angle control.
b) A 230v, 50Hz one pulse SCR controlled converter is triggered at a firing angle of 40^0 and the load current extinguishes at an angle of 210^0. Find the circuit turn off time, average output voltage and the average load current for
a) R = 5Ω, L = 2mH
b) R = 5Ω, L = 2mH, E = 110v. [8+8]

4. Determine the expression for the following performance facts of single-phase fully controlled bridge converter
a) Input displacement factor b) Input power factor
c) DC voltage ratio d) Input current distortion factor
e) Input harmonic factor f) Voltage ripple factor
g) Active power input h) Reactive power input. [16]

5. Clearly explain the effect of source inductance on a three-phase full converter bridge by deriving expressions for output voltage with overlap and also the voltage regulation due to source inductance. [16]

6. Explain clearly the difference triggering modes of bidirectional triode thyristor. [16]

7.a) Explain the single pulse modulation technique of a pulse-width modulated inverter by deriving expression for rms value of output voltage.

b) What are the drawbacks of external control of dc input voltage method of voltage control in single phase inverter? [8+8]

8. Write short notes on:

a) Advantages of pulse-width modulation control over frequency – modulation control in a chopper control strategy.

b) Drawbacks of a basic series inverter.

c) Applications of a cyclo converter. [16]

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POWER ELECTRONICS
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Time: 3hours **Max. Marks: 80**

Answer any FIVE questions
All Questions Carry Equal Marks
- - -

1.a) A BJT is acting as a switch, the forward current gain β is in the range 8 to 40. The load resistance is $R_C = 11\Omega$. The dc supply voltage is $V_{CC} = 200v$ and the input voltage to the base circuit is $V_B = 10V$. Find
a) The value of R_B that results in saturation with an over drive factor of 5.
b) The β forced c) The power loss P_T in the transistor.

b) Discuss what would happen if gate is made positive with respect to cathode during the reverse blocking of a thyristor? [8+8]

2.a) Compare a BJT, MOSFET, IGBT with respect to the following:
a) Basel Gate Control Variable
b) Control characteristic.
c) Switching frequency
d) On-state voltage drop
e) Max voltage rating
f) Max current rating.

b) Write down the advantages and limitations of MOSFET and IGBT. [8+8]

3.a) Power flow from 1 phase source to load R can be controlled through the use of a thyristor. Discuss why this method of power flow control is called phase controlled converter?

b) A 230v, 50Hz one pulse SCR controlled converter is triggered at a firing angle of 40^0 and the load current extinguishes at an angle of 210^0. Find the circuit turn off time, average output voltage and the average load current for
a) $R = 5\Omega$, L=2mH b) $R = 5\Omega$, L = 2mH and E = 110v. [8+8]

4. Explain only the operation of a single phase fully controlled bridge converter for firing angle α for a R load (do not derive any expressions).
Derive the following expressions:
The converter is connected to a 120v, 50Hz supply. The load current I_a is continuous and its ripple content is negligible. The turns ratio of the transformer is unity. Express the input current in a Fourier series and determine the HF of the input current. [16]

5. A 3 phase M-3 converter is operated from 3-phase, 230v, 50Hz supply with load resistance $R = 10\Omega$. An average output voltage of 50% of the maximum possible output voltage is required. Determine
a) Firing angle b) Average and rms values of load current
c) Rectification efficiency. [16]

6.a) What is the output voltage range for the control range of the delay angle for a single phase bidirectional ac voltage controller?

b) What are the advantages and disadvantages of a cyclo converter? [8+8]

7. Explain clearly the force commutated thyristor half-bridge type inverter with all necessary waveforms and expressions. [16]

8. Write short notes on:
a) Jones chopper – Principle of operation only.
b) Requirements of a good inverter.
c) Advantages and disadvantages of a bidirectional TRIODE thyristor. [16]

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