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10EC73

Seventh Semester B.E. Degree Examination, Dec.2013/Jan.2014
Power Electronics

Time: 3 hrs. Max. Marks:100

Note: ***Answer FIVE full questions, selecting at least TWO questions from each part.***

PART – A

1 a. Draw the circuit diagram, and control characteristics of GTO, MCT and BJT. **(06 Marks)**

b. What are power Electronic circuits? Explain any two of them with circuit, input and output waveforms. **(06 Marks)**

c. What are the peripheral effects of power electronic equipments and mention the remedies? **(05 Marks)**

d. What are the applications of power MOSFET's? **(03 Marks)**

2 a. Mention the merits and demerits of power MOSFET's. **(04 Marks)**

b. Draw the transient model of BJT and explain the switching characteristic of bipolar transistor. **(08 Marks)**

c. What is the need of base drive control and in a power transistor? Explain anti saturation control. **(08 Marks)**

3 a. Explain the two transistor model of thyristor and derive an expression for anode current interms of current amplification factor and leakage current. **(08 Marks)**

b. For the thyristor circuit shown in Fig.Q.3(b), the SCR has a latching current of 50mA and is fixed by a pulse of length 50μsec. Show that without resistance R, the thyristor will fail to remain on, when the firing pulse ends and then find the maximum value of R to ensuring firing. **(06 Marks)**

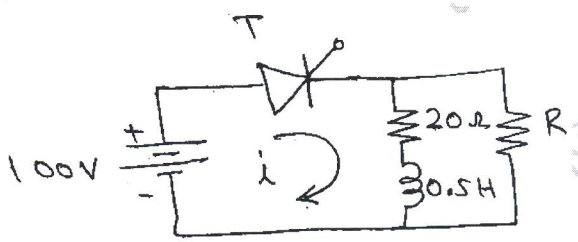


Fig.Q.3(b)

c. Design a UJT relaxation trigger circuit for SCR with V_{BB} = 20V, η = 0.6, I_p = 10μa, V^v = 2V and I_V = 10mA. The frequency of oscillation is 100Hz and triggering pulse width should be 50μsec. **(06 Marks)**

4 a. With the circuit and waveform, explain the operation of a single phase semi converter with inductive load. **(08 Marks)**

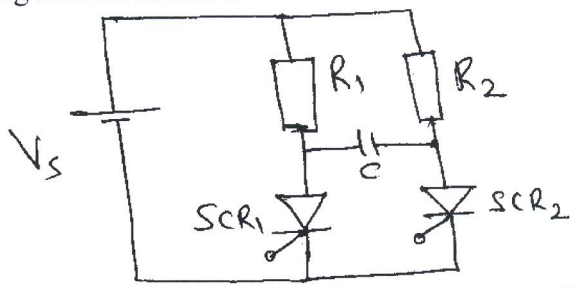
b. A single phase full converter is operated from a 120V, 60Hz supply. The load current with an average of I_a is continuous with negligible ripple current. If the delay angle is $\alpha = \frac{\pi}{3}$, calculate: i) Harmonic factor; ii) Displacement factor; iii) Power factor. **(07 Marks)**

c. What are the advantages of 1 - ϕ dual converter operation with circulating current. **(05 Marks)**

PART – B

5 a. Compare natural and forced commutation. **(05 Marks)**

b. Determine the proper values of the commutating components for the circuit shown in Fig.Q.5(b). The load current to be commutated is 5A, turn off time is 50μsec, supply voltage is 100V and SCR_2 holding current is 2mA. **(07 Marks)**



c. With the necessary circuit diagram and waveform, explain the operation of a complementary commutation. **(08 Marks)**

6 a. What are the applications of AC voltage controller? **(04 Marks)**

b. For the AC voltage controller shown in Fig.Q.6(b), calculate the average power in the lad if the thyristor firing angle is fixed at 45° with respect to supply voltage. Derive the necessary equation. **(08 Marks)**

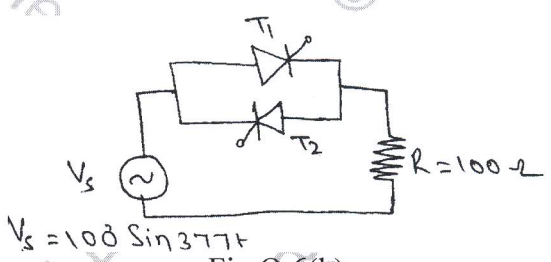


Fig.Q.6(b)

c. Explain the operation of a 1-ϕ controller with inductive loads and derive the expression of rms value of the output voltage. **(08 Marks)**

7 a. What are the applications of DC choppers? **(04 Marks)**

b. A DC chopper has a resistive load of 20Ω and input voltage 220V. When the chopper is on its voltage drop is 1.5V and chopping frequency is 10kHz. If the duty cycle is 80%, determine the average output voltage, rms value of the output voltage and chopper on time. **(07 Marks)**

c. Explain the operation of a step down chopper with RL load and also derive an expression of peak-peak output ripple current. **(09 Marks)**

8 a. Compare voltage source inverter and current source inverter. **(05 Marks)**

b. Explain the following performance parameters of a inverter:
   i) Harmonic factor of nth harmonic.
   ii) Total harmonic distortion.
   iii) Distortion factor. **(06 Marks)**

c. The single phase full bridge inverter has a resistive load of R = 24Ω and the DC input voltage of V_s = 48V. Determine:
   i) Rms output voltage at the fundamental frequency.
   ii) Output power.
   iii) Peak and average currents of each transistor. **(09 Marks)**

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06EC73

Seventh Semester B.E. Degree Examination, Dec.2013/Jan.2014

Power Electronics

Time: 3 hrs. Max. Marks:100

Note: ***Answer FIVE full questions, selecting at least TWO questions from each part.***

PART – A

1 a. Explain control characteristic features of the following power devices: i) SCR ii) MCT iii) IGBT **(12 Marks)**

b. Explain peripheral effects of converters. **(04 Marks)**

c. The maximum junction temperature of a transistor is $T_J = 150^oC$ and the ambient temperature is $T_A = 25^oC$. If the thermal impedance are $R_{JC} = 0.4^oC/W$, $R_{JA} = 0.1^oC/W$ and $R_{SA} = 0.5^oC/W$. Calculate:
i) The maximum power dissipation.
ii) The case temperature.
iii) Also draw the thermal equivalent circuit of a transistor. **(04 Marks)**

2 a. Explain switching characteristics of BJT with models. **(06 Marks)**

b. Explain working with basic structure of depletion type n and p channel MOSFETs with reference to transfer characteristic. **(08 Marks)**

c. The base drive circuit in Fig.Q2(c) has $V_{CC} = 100$ V, $V_{d_1} = 2.1$V, $V_{d_2} = 0.9$V, $V_{BE} = 0.7$V, $V_B = 15$V and $\beta = 16$. Calculate:
i) The collector current without clamping
ii) The collector-emitter clamping voltage V_{CE}.
iii) The collector current with clamping.

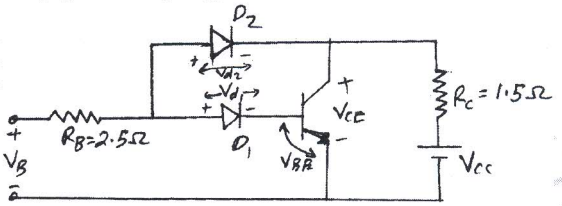

Fig.Q2(c) **(06 Marks)**

3 a. Explain turn-on mechanism of a thyristor using two transistor analogy and derive an expression for the anode current in terms of transistor parameters. **(08 Marks)**

b. With the help of neat circuit diagram and waveforms, explain the UJT-triggering circuit. Also mention its advantages over RC triggering. **(10 Marks)**

c. If the latching current for SCR inserted in between a dc voltage source of 100 V and an inductance load L = 0.1 H is 4 mA. Calculate the minimum width of gate pulse current required to turn-on SCR. **(02 Marks)**

4 a. If a converter shown in Fig.Q4(a) has a purely resistive load of R and the delay angle is $\alpha = \pi/2$. Determine: i) η, ii) Form factor, iii) Ripple factor, iv) TUF, v) PIV of thyristor.

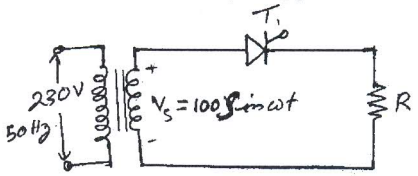

Fig.Q4(a) **(10 Marks)**

4 b. Explain the working of dual converter with a neat circuit diagram. Also obtain waveform for voltage generating circulating current. **(10 Marks)**

PART – B

5 a. Mention drawbacks of self commutation (any three). **(03 Marks)**

b. Explain the operation of complementary commutation with neat circuit and waveforms. Also deduce equation of C for design consideration. **(12 Marks)**

c. Find the value of C for the commutation circuit shown in Fig.Q5(c). Given $I_{L_{max}}$ = 50 A, t_{off} of SCR_1 = 30 μsec, E_{dc} = 50 V. Assume 50% tolerance on turn-off time.

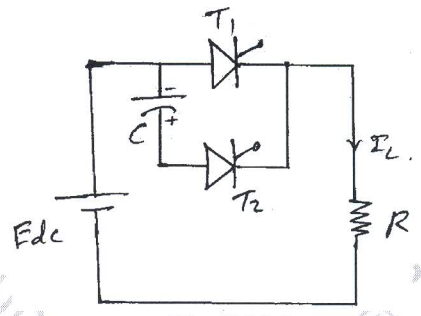

Fig.Q5(c) **(05 Marks)**

6 a. Explain the working of single phase bidirectional AC voltage controller for RL load considering discontinuous current flow through load with a neat circuit and waveforms. Derive equation for V_{orms}. **(10 Marks)**

b. An ac voltage controller has a resistive load of R = 10 Ω and $V_{S_{rms}}$ = 120 V, 60 Hz. The thyristors switch is on for n = 25 cycles and off for m = 75 cycles. Determine: i) V_{orms}, ii) load power, iii) input power factor, iv) $I_{T_{av}}$, v) $I_{T_{rms}}$. **(10 Marks)**

7 a. Explain the principle of operation of step-down chopper with a neat circuit and waveform. Derive the equations for $V_{0_{av}}$, $V_{0_{rms}}$, input power and input effective resistance. **(10 Marks)**

b. Find the converter efficiency if the load resistance R = 10 Ω, input supply dc voltage is 220, duty cycle is 50% and chopper voltage drop V_{ch} = 2V. (Converter is step-down chopper). **(06 Marks)**

c. Draw the circuit diagram and waveforms for step-up chopper. **(04 Marks)**

8 a. Explain current source inverter circuit with waveform. **(10 Marks)**

b. A 1-ϕ full bridge inverter has resistive load R = 2.4 Ω the dc input voltage V_S = 48V. Determine:

i) RMS output voltage at fundamental frequency.

ii) The output power.

iii) The average and peak current of each transistor. **(10 Marks)**

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06EC73

Seventh Semester B.E. Degree Examination, June / July 2013
Power Electronics

Time: 3 hrs. Max. Marks:100

Note: 1. ***Answer any FIVE full questions, selecting atleast TWO question from each part.***
2. Draw neat diagram and Waveforms, wherever possible.

PART – A

1 a. What is Power Electronics? Draw a neat block diagram of generalized power converter system. State the applications of power electronics. **(06 Marks)**

b. With neat circuit diagram and waveforms, explain the types of power electronic circuits. **(12 Marks)**

c. Compare General – purpose, Fast recovery and Schokky diodes. **(02 Marks)**

2 a. The maximum junction temperature of a transistor is $T_J = 150^0C$ and the ambient temperature is $T_A = 25^0C$, If the thermal impedances are $R_{JC} = 0.4^0C/W$, $R_{cs} = 0.1^0C/W$, and $R_{SA} = 0.5^0C/W$. Calculate i) the maximum power dissipation and ii) the case temperature. **(04 Marks)**

b. With the help of parasitic model and switching model, explain the switching waveforms of n – type (enhancement) MOSFET. **(10 Marks)**

c. Write a note on isolation of gate and base drives. **(06 Marks)**

3 a. Using a two transistor model of thyristor, show that $I_A = \frac{\alpha I_G + I_{CBO1} + I_{CBO2}}{1-(\alpha_1 + \alpha_2)}$. **(06 Marks)**

b. With neat sketch, explain turn – on characteristics of SCR. **(06 Marks)**

c. The input voltage Fig. Q3(c) is $V_s = 200V$ with load resistance of $R = 5\Omega$. The load and stray inductances are negligible and the thyristor is operated at a frequency of $f_s = 2KHz$. If the required dv/dt is 100 V/μS and the discharge current is limited to 100A. Determine i) the values of R_s and C_s ii) the snubber loss, and iii) the power rating of the snubber resistor. **(08 Marks)**

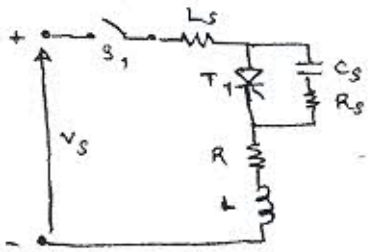

Fig. Q3 c. dv/dt protection circuit

4 a. Discuss the effect of inductance using the 1 - ϕ full converter. **(08 Marks)**

b. What is phase control? Explain the principal of phase control using 1 - ϕ half wave controlled rectifier. **(08 Marks)**

c. Compare circulating and non – circulating mode of operation of dual converter. **(04 Marks)**

PART – B

5 a. A thyristor circuit is shown in fig. Q5(a), if thyristor T_1 is switched on at t = 0, determine the conduction time of thyristor T_1 and the capacitor voltage after T_1 is turned off. The circuit parameters are L = 10μH, C = 50μF and V_s = 200V. The inductor carries an initial current of I_m = 250A. **(10 Marks)**

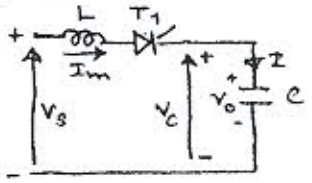

Fig. Q.5a : Self commutated circuit.

b. What is the principle of complementary commutation? Explain the same with the help of suitable circuit and waveforms. **(10 Marks)**

6 a. What is the principle of on off control? Explain the same with a single phase full – wave controller. **(06 Marks)**

b. Draw a neat sketch of 1 - ϕ AC voltage controller with RL load and explain its working. **(06 Marks)**

c. A single – phase full wave AC voltage controller has a resistive load of R = 10 Ω and the input voltage is V_s = 120V (rms), 60Hz. The delay angles of thyristors T_1 and T_2 are equal $\alpha_1 = \alpha_2 = \pi/2$. Determine i) the rms output voltage V_o ii) the input power factor PF iii) the average current of thyristor I_A and iv) the rms current of thyristor I_R. **(08 Marks)**

7 a. With a neat circuit diagram, explain the operation of a step down chopper and also explain constant frequency and variable frequency operation. Derive an expression for output voltage incase of step down chopper. **(10 Marks)**

b. A step – up chopper with a pulse width of 200μs operating on 200V, dc supply. Calcualte the output voltage, if the blocking period of the device is 50μs. **(02 Marks)**

c. With a neat circuit diagram and quadrant operation, explain class E chopper. **(08 Marks)**

8 a. With a neat circuit diagram, of 1 - ϕ half bridge inverter, explain the principle of operation of an inverter. **(08 Marks)**

b. Write brief note on current source inverter. **(06 Marks)**

c. With the help of circuit diagram and waveforms, explain a variable DC – link inverter. **(06 Marks)**

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06EC73

Seventh Semester B.E. Degree Examination, June 2012

Power Electronics

Time: 3 hrs. Max. Marks:100

Note: ***Answer FIVE full questions, selecting at least TWO questions from each part.***

PART – A

1 a. Give symbol and characteristic features of the following devices :
i) SCR ii) GTO iii) TRIAC iv) IGBT v) SIT **(10 Marks)**

b. Briefly explain any five types of power electronic circuits. **(10 Marks)**

2 a. What is the need for isolation of gate-drive circuits? Discuss the different methods of providing isolation of gate-drive circuits from power circuit. **(10 Marks)**

b. Discuss the switching limits of power transistors. **(10 Marks)**

3 a. With a neat diagram, explain the two-transistor model of a thyristor. Also, derive an expression for the anode current in terms of transistor parameters α_1 and α_2. **(08 Marks)**

b. What is the need of di/dt and dv/dt protection? Explain how protection is provided. **(04 Marks)**

c. With a neat circuit diagram and waveforms, explain UJT relaxation oscillator. **(08 Marks)**

4 a. With the necessary circuit diagram, waveforms and equations, explain the operation of single-phase full converter with R-L load. **(10 Marks)**

b. Explain single-phase semiconverter with a neat circuit diagram, waveforms and equations. **(10 Marks)**

PART – B

5 a. What is commutation? Explain complementary commutation with relevant circuit diagram and waveforms. **(10 Marks)**

b. For the auxiliary commutation circuit, calculate the values of the commutation capacitor and inductor for the following data:
$V_{d_c} = 30V$, $I_{L(max)} = 15A$, t_{off} of SCR1 = 20 μsec. **(04 Marks)**

c. With a neat circuit diagram and waveforms, explain external pulse commutation. **(06 Marks)**

6 a. With neat diagrams, waveforms and equations, discuss ON-OFF control and phase control of AC voltage controllers. **(12 Marks)**

b. A single-phase full-wave AC voltage controller has a resistive load 20Ω and the input voltage is 100 V (rms), 60 Hz. The delay angles of thyristors T_1 and T_2 are : $\alpha_1 = \alpha_2 = \alpha = \frac{\pi}{2}$.
Determine : i) The rms output voltage ; ii) The input power factor ; iii) The average current of thyristors ; iv) The rms current of thyristors. **(08 Marks)**

7 a. What is chopper? How they are classified? Briefly explain. **(10 Marks)**

b. With a neat circuit diagram and waveforms, explain impulse commutated chopper. **(10 Marks)**

8 a. Explain single-phase half-bridge inverter with R load, with necessary circuit diagram and waveforms. Derive the equation for rms output voltage. **(12 Marks)**

b. Explain the performance parameters of inverters. **(08 Marks)**

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06EC73

Seventh Semester B.E. Degree Examination, December 2011
Power Electronics

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions, selecting at least TWO questions from each part.***

PART – A

1 a. What are the important applications of power electronics? **(06 Marks)**

b. Explain peripheral effects of power converter system. **(06 Marks)**

c. Explain different types of power electronic converter circuits. **(08 Marks)**

2 a. Draw the equivalent model of BJT and explain the switching characteristics of power transistor. **(08 Marks)**

b. Compare the BJT and MOSFET. **(05 Marks)**

c. Discuss the different methods of providing isolation of gate drive circuits from power circuit. **(07 Marks)**

3 a. Explain the two transistor analogy of an SCR. Derive an expression for anode current. Also explain the process of regeneration cycle. **(10 Marks)**

b. Write a short note on $\frac{dv}{dt}$ and $\frac{di}{dt}$ protection. **(05 Marks)**

c. A UJT is connected across a 20 V DC supply. A valley and peak point voltages are 1 V and 15 V. The period of relaxation oscillation is 20 ms. Find the value of charging capacitor, if a charging resistor of 100 kΩ is used. **(05 Marks)**

4 a. Explain with the help of wave forms, 1-ϕ semi-converter (half bridge converter) with R-load. Derive an expression for V_0(avg) and V_0(rms). **(10 Marks)**

b. A single phase dual converter is operated from 120 V, 50 Hz supply and the load resistance R = 10 Ω the circulating inductance L_r = 40 mH delay angle are $\alpha_1 = 60°$ and $\alpha_2 = 120°$. Calculate the peak circulating current and peak current of converter. **(06 Marks)**

c. What is the use of free wheeling diode in a converter circuit? **(04 Marks)**

PART – B

5 a. Explain the self commutation with the help of neat sketch and obtain the expression for the capacitor voltage and current. **(10 Marks)**

b. Distinguish between the natural and forced commutation. **(05 Marks)**

c. In the parallel capacitor turn-off circuit shown in Fig. Q5 (c), the main SCRT, is to be reverse biased for at least 40 μs for proper commutation and holding current of auxiliary $SCRT_2$ is 2 mA. Determine the value of R and C. **(05 Marks)**

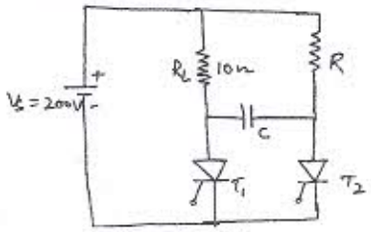

Fig. Q5 (c)

6 a. With the help of circuit diagram, explain the operation of single phase AC regulator using ON-OFF control. Derive the expression for rms value of load voltage. **(10 Marks)**

b. Explain the single phase bidirectional AC voltage controller with resistive load with waveform. **(10 Marks)**

7 a. With neat circuit diagram and explain the four quadrant chopper. **(08 Marks)**

b. With neat circuit diagram, explain the principle of operation of step up chopper. **(08 Marks)**

c. A chopper circuit is operating on Time Ration Control (TRC) at a frequency of 2 kHz on a 460 V supply of the load voltage of 350 V. Calculate the conduction period of the thyristors in each cycle. **(04 Marks)**

8 a. Explain the performance of inverters. **(06 Marks)**

b. With a neat circuit diagram, explain the principle of variable DC link. **(08 Marks)**

Write a short note on CSI (Current Source Inverter). **(06 Marks)**

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06EC73

Seventh Semester B.E. Degree Examination, June/July 2011
Power Electronics

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions, selecting at least TWO questions from each part.***

PART – A

1 a. Give the definition of power electronics. Explain the relationship of power electronics to power, electronics and control. Mention any two applications of PE. **(06 Marks)**

b. With the circuit diagram, input and output waveforms, explain the control characteristics of SCR and IGBT. **(06 Marks)**

c. Explain any four different types of power converter circuits with the circuit, input and output waveforms. Also, mention one application of each type. **(08 Marks)**

2 a. What is the necessity of base drive control in a power transistor? Explain proportional base control. **(08 Marks)**

b. A transistor switch of Fig.Q2(b) has β in the range of 8 to 40. Calculate i) the value of R_B that results in saturation, with an overdrive factor of 5. ii) The forced β_f and iii) The power loss in the transistor. **(06 Marks)**

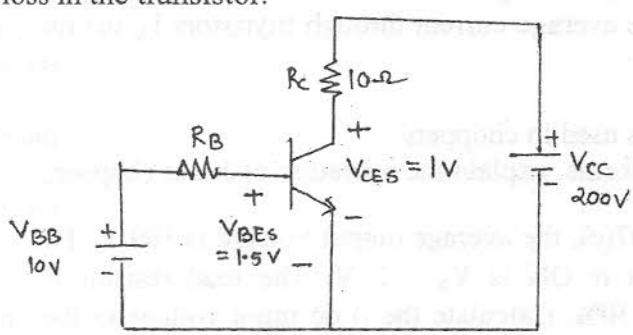

Fig.Q2(b)

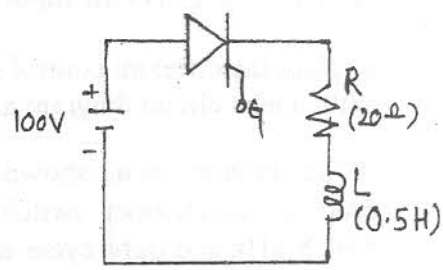

Fig.Q3(c)

c. With necessary sketches, explain briefly the switching characteristics of an IGBT. **(06 Marks)**

3 a. Sketch the gate characteristics of an SCR and explain the different regions of gate characteristics. Also indicate different regions, different voltages and different currents on the gate characteristics. **(10 Marks)**

b. With a neat circuit diagram and waveforms, explain the resistor triggering circuit. **(06 Marks)**

c. The latching current of a thyristor shown in Fig.Q3(c) is 50 mA. The duration of gate pulse is 50 μsec. Will the thyristor get fired? **(04 Marks)**

4 a. With a neat circuit diagram and waveforms, explain the working of a single phase full converter feeding highly inductive load. Derive the expression for the average output voltage and rms output voltage. **(10 Marks)**

b. Give the equations to show that the power factor of semiconverter is better than that of full converter. **(04 Marks)**

c. Design UJT relaxation oscillator for triggering of thyristor. The UJT has the following parameters $\eta = 0.7$, $I_P = 50\ \mu A$, $V_V = 2V$, $I_V = 6$ mA, $V_{BB} = 20V$, $R_{BB} = 7\ k\Omega$, $I_{EO} = 2$ mA. Also determine the limits for the output frequency of the oscillator. Assume $V_{g(min)} = 0.2V$. **(06 Marks)**

PART – A

5 a. With a neat circuit diagram and waveforms, explain the auxiliary commutation. **(10 Marks)**

b. For the complementary commutation circuit show in Fig.Q5(b), calculate the values of C to provide circuit turn off time of 20 μsec. **(06 Marks)**

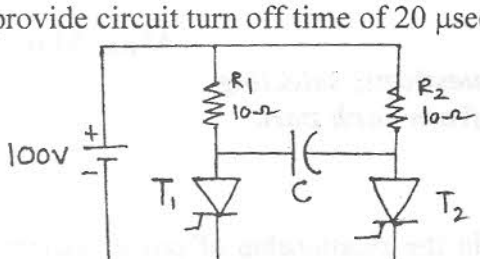

Fig.Q5(b)

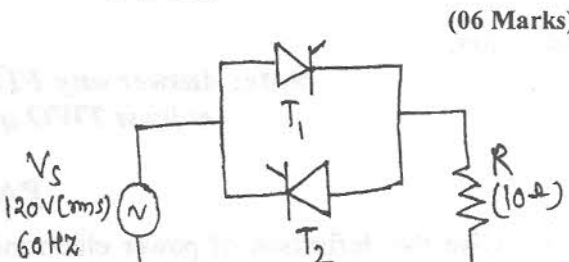

Fig.Q6(c)

c. State the conditions under which load carrying thyristor can be successfully commutated. **(04 Marks)**

6 a. With a necessary waveforms, explain the operation of a single phase full wave controller with inductive load. Derive the expression for rms output voltage. **(08 Marks)**

b. What is an ac voltage controller? With the help of circuit diagram and waveform, explain the principle of phase control. **(06 Marks)**

c. A 1ϕ full wave ACVC has a resistive load of R = 10 Ω as shown in Fig.Q6(c). The input is V_S = 120 V(rms), 60 Hz. The delay angle of thyristors T_1 and T_2 are equal to $\alpha_1 = \alpha_2 = \pi/2$. Calculate i) rms output voltage ii) the average current through thyristors I_A iii) rms current of thyristors I_R iv) the input P.F. **(06 Marks)**

7 a. Explain the different control strategies used in choppers. **(06 Marks)**

b. With a neat circuit diagram and waveforms, explain the operation of Jones chopper. **(10 Marks)**

c. In the chopper circuit shown in Fig.Q7(c), the average output voltage is 109 V. The voltage drop across chopper switch when it is ON is V_S = 2 V. The load resistor R = 10Ω f =1.5 kHz and duty cycle ratio δ = 50%. Calculate the i) dc input voltage to the chopper ii) rms output voltage. **(04 Marks)**

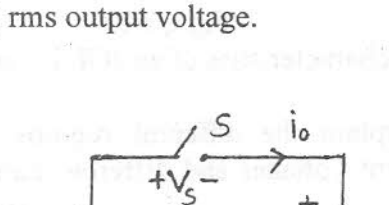

Fig.Q7(c)

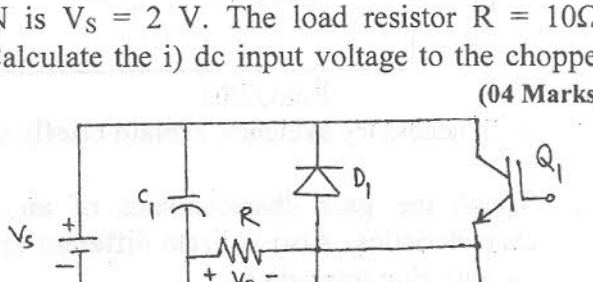

Fig.Q8(c)

8 a. With necessary sketches, explain the single phase transistorized current source inverter. **(08 Marks)**

b. With necessary waveforms, explain the single pulse width modulation technique of varying the magnitude of output voltage in a single-phase inverter. **(06 Marks)**

c. The single phase bridge inverter in Fig.Q8(c) has a resistive load of R = 2.4Ω and the d input voltage is V_S = 48V. Calculate i) the rms output voltage at the fundamental frequency V_{01} ii) the output power iii) the average and peak currents of each transisto iv) the peak reverse blocking voltage V_{BR} of each transistor v) the THD vi) D.F. **(06 Marks)**

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EC7T4

Seventh Semester B.E. Degree Examination, June/July 2011

Power Electronics

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions.***

1 a. Explain the TRIAC characteristics. **(08 Marks)**
b. With a neat sketch, explain the static V-I characteristics of an SCR. **(07 Marks)**
c. With a circuit diagram, explain R-triggering circuit. **(05 Marks)**

2 a. Explain the single-phase full wave converters. **(10 Marks)**
b. Explain the single-phase dual-converters. **(10 Marks)**

3 a. With necessary circuit diagram and waveforms, explain the impulse commutation. **(10 Marks)**
b. The resonant-pulse commutation circuit in Fig.Q3(b) has capacitance C = 30 μF and inductance L = 4 μH. The initial capacitor voltage is V_o = 200 volts. Determine the circuit turn-off time t_{off}, if the load current I_m is (i) 250 Amps (ii) 50 Amps. **(10 Marks)**

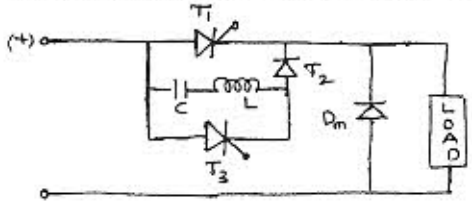

Fig.Q3(b)

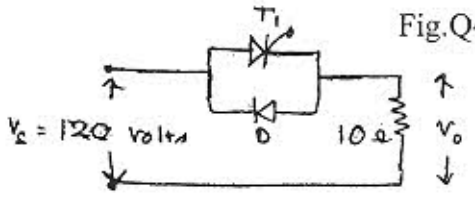

Fig.Q4(b)

4 a. Derive an expression for the rms value of output voltage of a bidirectional AC voltage controller, employing ON-OFF control. **(10 Marks)**
b. A single phase half wave AC voltage controller shown in Fig.Q4(b) feeds power to a resistive load of 10Ω from 120 volt, 60 Hz source. The firing angle of SCR is $\alpha = \pi/2$. Calculate: i) RMS value of output voltage , ii) Input p.f., iii) Average input current. **(10 Marks)**

5 a. With the help of a neat circuit diagram, explain the principle of working of a step-down chopper. **(10 Marks)**
b. The DC chopper has a resistive load of R = 10Ω and the input voltage is V_s = 220 volts, when the chopper switch remains ON, its voltage drop is V_{ch} = 2 volts and the chopping frequency is f = 1 kHz. If the duty cycle is 50%. Determine :
i) The average output voltage V_a ii) The rms output voltage V_o
iii) The chopper efficiency iv) The effective input resistance. **(10 Marks)**

6 a. With the help of a circuit diagram, explain the principle of working of a step-up chopper. **(10 Marks)**
b. With the help of a circuit diagram, explain the switching mode regulators. **(10 Marks)**

7 a. Explain the open loop block diagram of separately excited DC motor. **(10 Marks)**
b. Explain the closed loop block diagram of separately excited DC motor. **(10 Marks)**

8 Write short notes on :
a. Classification of choppers **(08 Marks)**
b. Snubber circuits **(06 Marks)**
c. Distinguish between ON-OFF control and phase control of AC voltage controllers. **(06 Marks)**

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06EC73

Seventh Semester B.E. Degree Examination, December 2010
Power Electronics

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions, selecting at least TWO questions from each part.***

PART – A

1 a. Mention and explain the different types of power electronic converter systems. Draw their input/output characteristics. **(06 Marks)**

b. Mention and explain the classification of power semiconductor switching devices, on the basis of control characteristics. Give an examples. **(06 Marks)**

c. Give symbol, characteristic features of the following devices :
i) GTO ; ii) TRIAC ; iii) MOSFET ; v) MCT. **(08 Marks)**

2 a. With the necessary waveforms, explain the switching characteristics of a power transistor. **(08 Marks)**

b. The bipolar transistor of Fig.Q.2(b) is specified to have β 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 $V_B = 10V$. $V_{ce\ (sat)} = 1.0V$ and $V_{BE\ (sat)} = 1.5V$. Find : i) The value of R_B that results in saturation with an overdrive factor of 5 ; ii) The forced β_f ; iii) The power loss P_T in the transistor. **(06 Marks)**

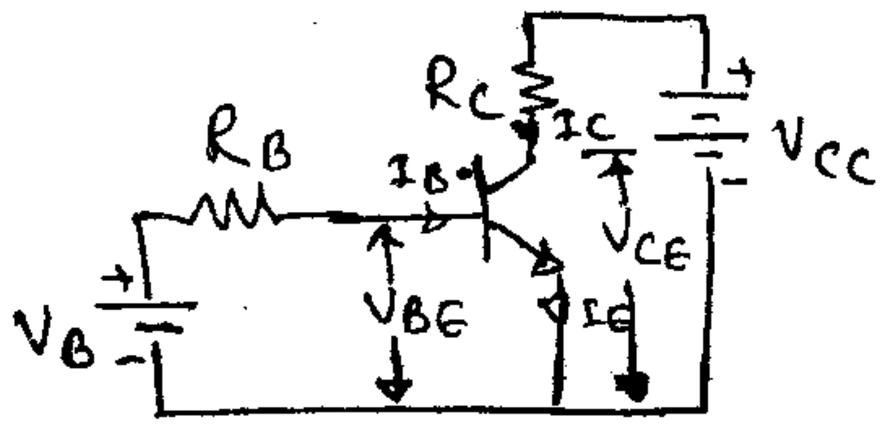

Fig.Q.2(b).

c. Give the comparison between MOSFET and IGBT. **(06 Marks)**

3 a. Draw the two transistor model of a thyristor and derive an expression for the anode current in terms of the common base current gain α_1 and α_2 of the transistors. **(08 Marks)**

b. Distinguish between :
i) Latching current and holding current.
ii) Converter grade thyristor and inverter grade thyristor.
iii) Thyristor turn – off time and circuit turn – off time. **(08 Marks)**

c. A thyristor is supplied from 230V, 50Hz mains. If the conduction angle is 120°, determine the voltage at which the thyristor is triggered. **(04 Marks)**

4 a. With the necessary circuit and waveforms, explain the principle of operation of single phase full converter with R – L load. Derive an expression for the average output voltage. **(08 Marks)**

b. With a neat circuit diagram, and waveforms, explain the principle of operation of dual converter, with and without circulating current. **(08 Marks)**

c. What are the advantages and drawbacks of circulating current mode of operation of a dual converter? **(04 Marks)**

PART – B

5 a. What do you mean by commutation? Explain briefly the different types of commutation. **(08 Marks)**

b. With necessary circuit and waveforms, explain self commutation scheme. **(06 Marks)**

c. In the impulse commutated thyristor circuit of Fig.Q.5(c), determine the available turn – off time of the circuit, if $V_S = 200V$, $R = 10\ \Omega$ $C = 5\ \mu F$ and $V_O = V_S$. **(06 Marks)**

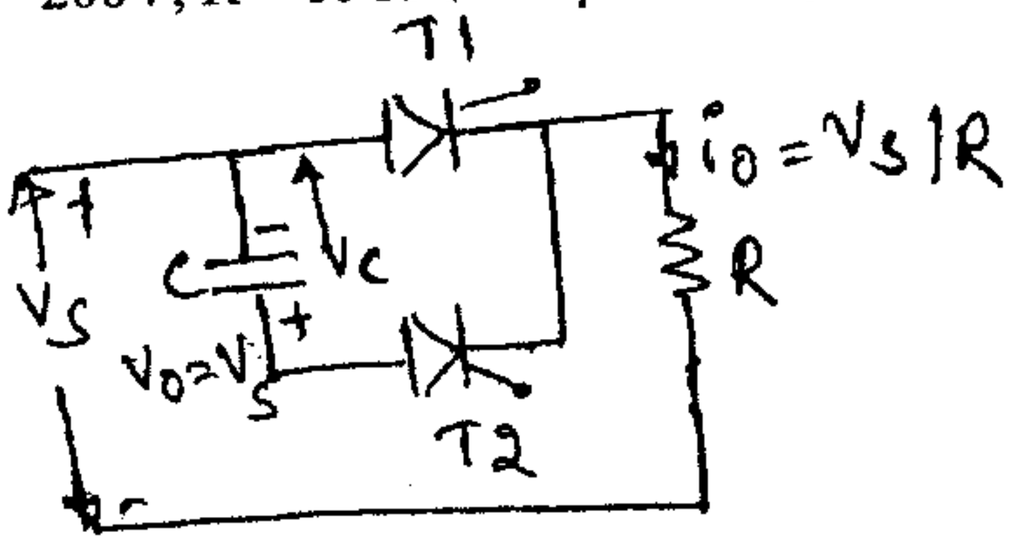

Fig.Q.5(c).

6 a. Define the following ;
i) Delay angle ; ii) Extinction angle ; iii) Conduction angle. **(03 Marks)**

b. What problem is caused by sharp single pulse triggering in a 1 ϕ AC voltage controller, when the load is inductive? How can this be solved? **(05 Marks)**

c. A 1 ϕ halfwave ac voltage controller has an input voltage of 230 V, 50 Hz and a load resistance of 10 Ω. The firing angle of thyristor is 90° in each positive half cycle. Find :
i) Average output voltage.
ii) RMS output voltage.
iii) The average thyristor current.
iv) The rms current value of the thyrsitor.
v) Diode average current.
vi) Diode rms current. **(12 Marks)**

7 a. Give the classification of choppers. Explain class E chopper with circuit and quadrant diagram. **(06 Marks)**

b. A chopper is feeding an RL load as shown in Fig.Q.7(b). The chopper frequency is 1 kHz and duty cycle $K = 0.5$.
Calculate :
i) The minimum instantaneous load current I_1 ; ii) The peak instantaneous load current I_2 ;
iii) The average value of load current I_a ; iv) The rms load current I_o. **(08 Marks)**

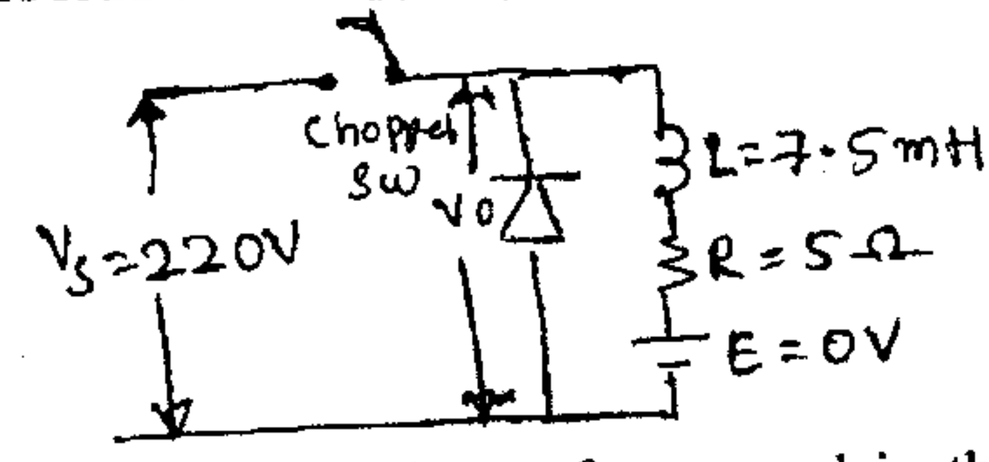

Fig.Q.7(b).

c. With the help of a circuit diagram and waveforms, explain the working principle of a step - up chopper. **(06 Marks)**

8 a. What do you mean by inverters? Explain the principle of operation of 1 ϕ half bridge inverter. **(08 Marks)**

b. Write and explain the performance parameters of an inverter. **(06 Marks)**

c. With a neat circuit, explain the variable DC link inverter. **(06 Marks)**

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1998 SCHEME

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EC7T4

Seventh Semester B.E. Degree Examination, December 2010
Power Electronics

Time: 3 hrs. Max. Marks:100

Note: ***1. Answer any FIVE full questions.***
2. Assume suitable data, if required.

1 a. Mention and explain the different types of power electronic controllers. Draw their input/output characteristics. **(08 Marks)**

b. Give the comparison of SCR, MOSFET and IGBT, with the applications of each. **(08 Marks)**

c. The thyristor is gated with a pulse width of 40 μ sec. The latching current of thyristor is 36 mA. For a load of 60 Ω and 2 H, will the thyristor get turned on? If not, how it can be overcome for the given load? Find its value. **(04 Marks)**

2 a. Sketch the static V-I characteristics of an SCR and explain the latching current, holding current and break over voltage. **(08 Marks)**

b. Using two-transistor model, explain the switching action and significance of gate control. Also derive an expression for the anode current. **(08 Marks)**

c. What are the various methods of turn – on the SCR? Mention the advantages of gate triggering. **(04 Marks)**

3 a. What are the advantages of freewheeling diode? Explain the principle of operation of single phase HWR feeding RL load. Draw the necessary sketches. **(08 Marks)**

b. With the necessary circuit and waveforms, explain the operation of three phase full converter. **(08 Marks)**

c. A single phase rectifier with 10 kW rating is required. Thyristors of current rating 50 A are to be used. Find the rated voltage of thyristor using a safety factor 2, if the rectifier is full wave bridge type. **(04 Marks)**

4 a. What do you mean by commutation? Explain, briefly, the different types of commutation. **(08 Marks)**

b. With necessary circuit and waveforms, explain complementary commutation scheme. **(08 Marks)**

c. The resonant pulse commutation circuit has a capacitance C = 30 μF and L = μH, the initial capacitor voltage is V_o = 200V. Determine the circuit turn off time for the load current I_m = 250 A. **(04 Marks)**

5 a. With necessary circuit and waveforms, explain the operation of full wave AC voltage controller feeding RL load. **(08 Marks)**

b. Explain the various methods of gating an SCR. State why short duration pulses are insufficient for an AC voltage controller feeding an RL load. **(06 Marks)**

c. A single phase AC voltage controller has an input voltage of 150V and a load resistance of 8Ω. The firing angle of SCR is 60° in each half cycle. Find out RMS and average output voltage, P_i and P_o. **(06 Marks)**

EC7T4

6 a. Explain how DC choppers are classified with reference to the load voltage and load current. **(10 Marks)**

b. Write a short note on step up chopper. **(04 Marks)**

c. ADC chopper of type A has a resistive load R = 20 Ω and input voltage of 220V. When chopper remains ON, its voltage drop is 1.5 V and chopping frequency is 10 kHz. If the duty cycle is 80%, determine :

i) Average output voltage
ii) rms output voltage
iii) Chopper efficiency
iv) Effective input resistance R_i. **(06 Marks)**

7 a. With the help of a neat sketch and associated waveforms, describe the operation of buck – regulator. **(10 Marks)**

b. Develop an expression for the open loop transfer function of a separately excited DC motor. **(10 Marks)**

8 Write short notes on :

a. dv/dt and di/dt protection.
b. Bipolar junction transistor and its applications.
c. Effect of source and load inductance.
d. Rating of thyristors. **(20 Marks)**

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2002 SCHEME

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EC42

Fourth Semester B.E. Degree Examination, December 2010
Power Electronics

Time: 3 hrs. Max. Marks:100

Note: 1. ***Answer any FIVE full questions.***
2. ***Missing data may be suitably assumed.***

1 a. Give the circuit symbol, V-I characteristics and applications of various semiconductor devices. **(08 Marks)**

b. Mention and explain the various types of power electronic converters. **(06 Marks)**

c. With the help of necessary waveforms, explain the switching characteristics of a transistor. **(06 Marks)**

2 a. Give the constructional details and switching characteristics of a power MOSFET. **(07 Marks)**

b. What is the need of base drive control? Explain the proportional control and anti-saturation control. **(07 Marks)**

c. The bipolar transistor is to have a range of β from 8 to 40. The load resistance $R_C = 11\ \Omega$. The d.c. supply voltage V_{cc} = 200 V and the input voltage to the base circuit is V_B = 10 V. If $V_{CE(sat)}$ = 1.5 V, find

i) R_B that results in saturation with an override factor of 5m

ii) Forced B_f.

iii) Power loss in the transistor.

Refer Fig. Q2 (c). **(06 Marks)**

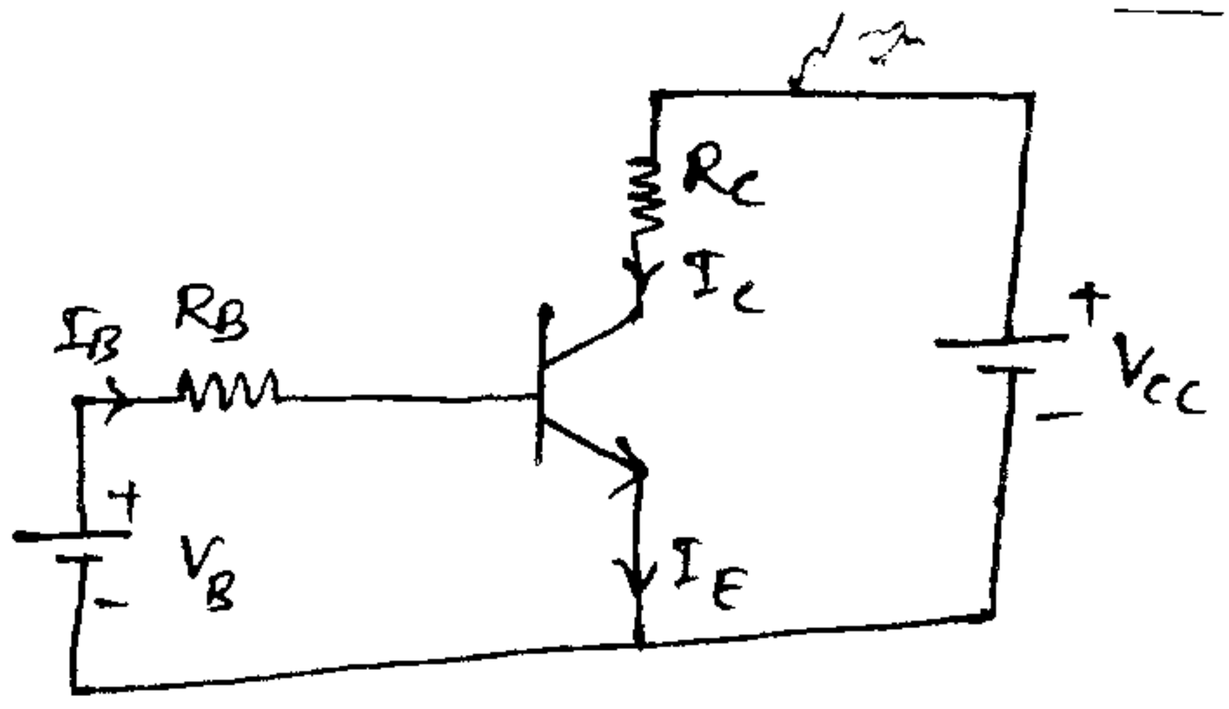

Fig. Q2 (c)

3 a. Explain the static V-I characteristics of an SCR. **(06 Marks)**

b. Mention and explain the various methods of turn ON of an SCR. **(08 Marks)**

c. SCRs with ratings of 1000 V and 20 A are available, to be used in a string, to handle 6 KV and 1 KA. Calculate the number of series and parallel units required, in case the derating factor is i) 0.1 and ii) 0.2. **(06 Marks)**

4 a. What do you mean by commutation? Explain the line commutation and load commutation. **(07 Marks)**

b. With the help of a circuit diagram and waveforms, explain the operation of complementory commutation. **(07 Marks)**

EC42

4 c. The resonant pulse commutation circuit shown in figure Q4 (c) has a capacitance C = 30 μH and inductance L = 4 μH. The initial capacitor voltage V_o = 200 V. Determine the circuit turn-off time t_{off} if the load current I_m = 250 A. **(06 Marks)**

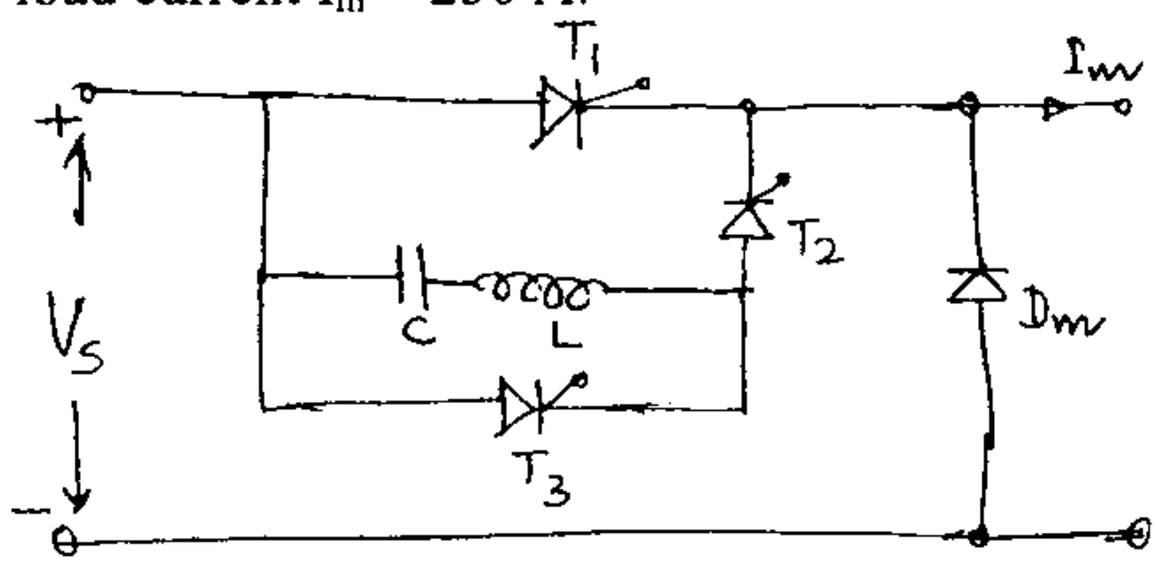

Fig. Q4 (c)

5 a. With the necessary circuit and waveforms, explain the operation of a single phase voltage controller, feeding an R-L load. **(08 Marks)**

b. Explain why a short pulse is not sufficient to trigger the thyristor, in case of a single phase AC voltage controller, with RL load. **(05 Marks)**

c. A single phase voltage controller has input voltage of 230 V, a frequency 50 Hz and a load of R = 15 Ω. For 6 cycles ON and 4 cycles OFF, determine, i) RMS output voltage ii) Input power factor iii) Average and RMS thyristor current. **(07 Marks)**

6 a. Mention the applications of converters. Explain the principle of operation of a single phase half wave rectifier with R-L load involving free wheeling diode. **(07 Marks)**

b. With the necessary circuit diagram and waveforms, explain the principle of operation of a single phase dual converter. **(07 Marks)**

c. A single phase full converter, operating from a 230 V, 50 Hz supply, has a pure resistive load of R = 15 Ω. If the average load current is 11.78 A, calculate, i) Delay angle α ii) RMS output voltage and current iii) Average and RMS thyristor current. **(06 Marks)**

7 a. With the help of circuit diagram and their operating characteristics, explain the various types of chopper circuit configurations. **(08 Marks)**

b. With the help of the basic circuit, explain the operation of step up chopper. Discuss the methods of duty cycle control. **(08 Marks)**

c. A step down chopper is operating from a 220 V d.c. source. The load has R = 5 Ω and a very large inductance, so that load current may be assumed to be constant at 22 A. If the chopper frequency is 250 Hz, calculate the ON and OFF period and duty cycle of the chopper. **(04 Marks)**

8 a. Give the comparison between single phase half bridge and full bridge inverter. **(08 Marks)**

b. With the help of necessary circuit and waveforms, explain the operation of a 3-phase inverter, operating in 180° mode operation. **(07 Marks)**

c. For a single phase full bridge inverter, V_S = 230 V, T = 1 ms. The load consists of RLC in series with R = 1 Ω, WL = 6 Ω and $\frac{1}{WC} = 7\Omega$. (i) Sketch the waveforms for load voltage V_o, fundamental component of load current i_{01} and the voltage across the thyristor. **(05 Marks)**

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06EC73

Seventh Semester B.E. Degree Examination, May/June 2010
Power Electronics

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions, selecting at least TWO questions from each part.***

PART – A

1 a. List out some applications of power controller. **(06 Marks)**

b. Write the characteristic features of following power devices.
i) SCR ; ii) TRIAC ; iii) LASCR ; iv) MCT ; v) SITH. **(10 Marks)**

c. Compare the characteristic of power MOSFET and 1GBT. **(04 Marks)**

2 a. Discuss the steady state characteristics power MOSFETS compare this with characteristics of power BJT. **(10 Marks)**

b. The beta (β) bipolar transistor shown in Fig.2(b) below varies from 12 to 75. The load resistance R_C = 1.5 Ω. The dc supply voltage is V_{CC} = 40 V and input voltage to the base circuit V_B = 6V, if $V_{CE(sat)}$ = 1.2 V, $V_{BE(sat)}$ = 1.6 V, R_B = 0.7 Ω. Determine :
i) Overdrive factor (ODF)
ii) The forced β and
iii) The power loss in the transistor P_T. **(10 Marks)**

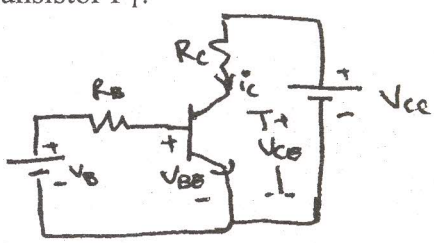

Fig.2(b)

3 a. Define the following term with respect to SCR :
i) Latching current ; ii) Holding current
iii) Turn-on time ; iv)Turn off time. **(08 Marks)**

b. The latching current for SCR inserted in between a dc voltage source of 200 V and load is 100 mA. Calculate the minimum width gate pulse current required to turn-on this SCR in case the load consist of i) L = 0.2 H ; ii) R = 20 Ω in series with L = 0.2 H. **(06 Marks)**

c. With help of neat circuit diagram and waveforms, explain RC firing circuit used with half controlled rectifier. **(06 Marks)**

4 a. What is the need of di/dt protection and dv/dt protection? Explain how protection is provided. **(04 Marks)**

b. The input voltage of Fig.4(b), V_s = 200 V with load resistance R = 5 Ω and the load and stray inductance are negligible and thyristor is operated at f_s = 2 kHz. If the required dv/dt is 100 V/μs. The discharge current is limited to 100 A. Determine :
i) The values R_s and C_s ; ii) The snubber loss. **(08 Marks)**

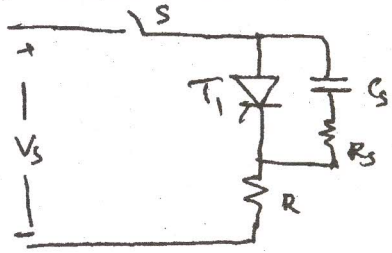

Fig.4(b)

c. Explain the operation of single phase semi-converter with highly inductive load. Derive the expression for V_{dc} and V_{rms}. **(08 Marks)**

PART – B

5 a. What is forced commutation? With help of neat diagram and relevant equations, explain the operations of self commutation circuit. **(10 Marks)**

b. Derive the equation for turn-off time of SCR in impulse commutated circuit for the following circuit. For the impulse commutated thyristor circuit shown in Fig.5(b). Determine turn-off time of the circuit for R = 10 Ω and C = 20 μF and supply voltage V_s = 220 V. **(10 Marks)**

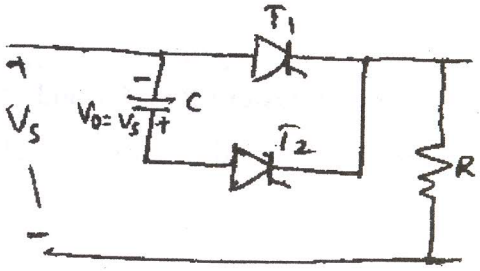

Fig.5(b)

6 a. What are advantages and disadvantages ON-OFF control and phase control of ac voltage controller? **(08 Marks)**

b. For the AC voltage controller shown in the following fig.6(b), the delay angles of thyristors are equal and $\alpha_1 = \alpha_2 = \frac{2\pi}{3}$. Determine the :

i) RMS O/P voltage
ii) Input power factor
iii) Average and Rms current of the thyristors.

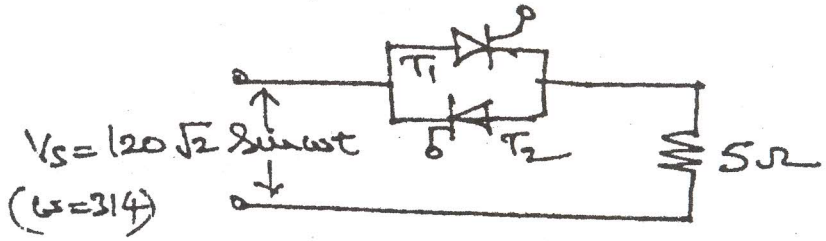

Fig.6(b)

(12 Marks)

7 a. What is chopper? Explain principle of step up chopper with relevant equations. **(10 Marks)**

b. Give the classification of chopper. Explain briefly each one of them. **(10 Marks)**

8 a. Write the principle of operation of 1 - ϕ inverter with relevant diagram and waveform. Also discuss the performance parameter. **(10 Marks)**

b. The 1 - ϕ full bridge inverter has resistive load R = 2.4 Ω the dc input voltage V_s = 48 V. Determine :

i) RMS output voltage at fundamental frequency
ii) The output power
iii) The average and peak current of each transistor. **(10 Marks)**

2002 SCHEME

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EC42

Fourth Semester B.E. Degree Examination, May/June 2010
Power Electronics

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions.***

1 a. What are the different types of power electronics circuits? Write circuit diagrams and wave forms for each type. **(06 Marks)**

b. Write the control characteristics of i) SCR ; ii) Transistor ; iii) MOSFET ; iv) MCT. **(04 Marks)**

c. Explain with a neat circuit diagram and waveform, working of a 3-ph half wave converter. **(10 Marks)**

2 a. Draw and explain the output characteristics of n-channel enhancement mode MOSFET. **(06 Marks)**

b. List the differences between BJT and MOSFET. **(04 Marks)**

c. The data (β) of bipolar transistor shown in Fig.2(c) varies from 10 to 60. The load resistance is Rc = 5 Ω. The dc supply voltage is Vcc = 100 V and the input voltage to base circuit is V_B = 8V. If V_{CE} = 2.5 V and V_{BE} = 1.75 V. Find :

i) The value of R_B that will result in saturation with an over drive factor of 20.

ii) The forced β and

iii) Power losses in transistor. **(10 Marks)**

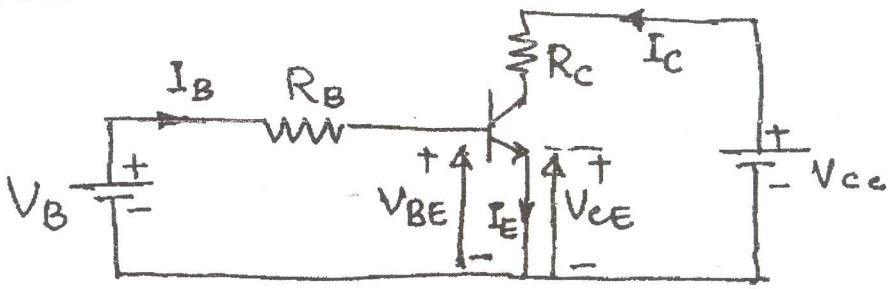

Fig.2(c).

3 a. With a neat circuit diagram, explain the two transistor analogy of an SCR. **(08 Marks)**

b. What is the purpose of di/dt and dv/dt protection? **(04 Marks)**

c. Ten thyristors are used in a string to withstand a dc voltage of V_s = 15 kV. The maximum leakage current and recovery charge differences of thyristors are 10 mA and 15 μC respectively. Each thyristor has a voltage sharing resistance of R = 56 kΩ and capacitance of C1 = 0.5 μF. Determine :

i) The maximum steady state voltage sharing $V_{DS\ (max)}$

ii) The steady state voltage derating factor

iii) The maximum transient voltage sharing $V_{DT(max)}$

iv) The transient voltage derating factor. **(08 Marks)**

4 a. What do you mean by commutation of SCR? What are the types of forced commutation? **(04 Marks)**

b. With a neat circuit diagram and wave form, explain self commutation of thyristor. **(06 Marks)**

c. A resonant pulse commutation circuit shown in Fig.4(c) has capacitance C = 30 μF and inductance = 4 μH. The initial capacitor voltage Vo = 200 V. Determine the circuit turn – off time t_{off} if load current I_m is i) 250 A ; ii) 50 A. **(10 Marks)**

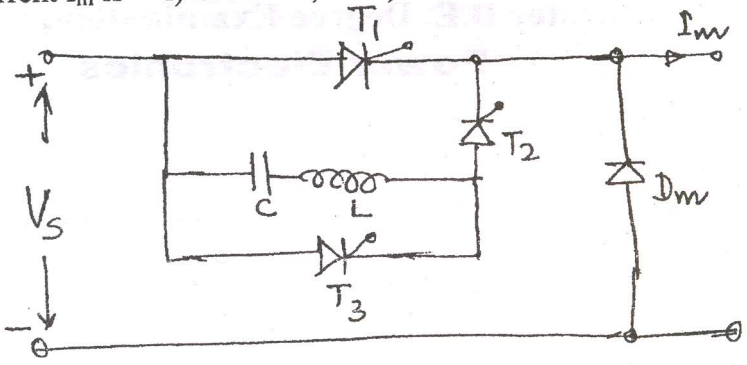

Fig.4(c).

5 a. What are the gate signal requirements of thyristors for voltage controllers with RL load? Explain with example. **(06 Marks)**

b. Explain with a neat circuit diagram and waveform, working of single phase full wave controller with resistance load. **(06 Marks)**

c. A single phase full wave AC voltage controller has a resistance load of R = 5 Ω and input voltage Vs = 120 V (RMS), 60 Hz. The delay angles of thyristor T1 and T2 are equal. $\alpha_1 = \alpha_2 = \alpha = 2\pi/3$. Determine :

i) The RMS output voltage Vo
ii) The input power factor and
iii) The average current of thyristor I_A. **(08 Marks)**

6 a. Explain with a neat circuit diagram and waveform, working of single phase semiconverter with RL load. **(06 Marks)**

b. Derive an expression to find the RMS value of output voltage of single phase full wave converter, with RL load. **(06 Marks)**

c. With a neat circuit diagram and waveform, explain the working of a dual converter. **(08 Marks)**

7 a. With a neat circuit diagram and waveform, explain the principle of a operation of step down chopper. **(06 Marks)**

b. Explain the classification of chopper with neat circuit diagram and waveform. **(10 Marks)**

c. A step down chopper has a resistive load R = 20 Ω and I/P voltage Vs = 220 V. When the chopper remains ON, its voltage drop is V_{ch} = 1.5 V and chopping frequency is f = 10 kHz. If duty cycle is 10%, determine : i) Average output voltage Va ; ii) RMS output voltage Vo. **(04 Marks)**

8 a. Explain with a neat circuit diagram and waveform, the principle of operation of 1 – ph inverter. **(08 Marks)**

b. Explain with neat circuit diagram and waveform, 3-phase inverter with resistive load in 180° conduction mode. **(12 Marks)**

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06EC73

SET-1

Seventh Semester B.E. Degree Examination, Dec.09/Jan.10
Power Electronics

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions, selecting at least TWO questions from each part.***

PART – A

1 a. Explain the control characteristics of SCR and GTO with circuit diagrams and wave forms of control signal and output voltage. **(08 Marks)**

b. Explain in brief the different types of power electronic converter circuits and mention the type of input supply given and its related output in each case. Also indicate two applications in each case. **(10 Marks)**

c. What is secondary break down? **(02 Marks)**

2 a. Compare an SCR with BJT. **(06 Marks)**

b. For the switching circuit shown in Fig. Q2(b) calculate :

i) The forced β of transistor

ii) The minimum ODF if the manufacturer specified β is 10

iii) The power loss P_T of the transistor. **(06 Marks)**

V_{CC} = 100V; V_B = 5V; R_B = 0.8 Ω; R_C = 12Ω; $V_{CE(sat)}$ = 1.0 V; $V_{BE(sat)}$ = 1.5 V.

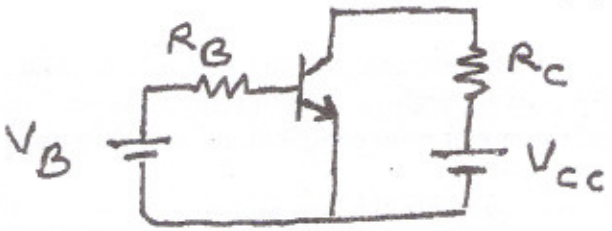

Fig. Q2(b)

c. What is the need for isolation of gate drive circuits? Discuss the different methods of providing isolation of gate drive circuits from power circuit. **(08 Marks)**

3 a. Explain the turn on mechanism of a thyristor using two transistor analogy and derive an expression for the anode current in terms of transistor parameters. **(08 Marks)**

b. In the thyristor circuit shown in Fig. Q3(b) the thyristor has a latching current of 20 m A and is fired by a gate pulse of width 50 μs. Show that without the resistance R, the thyristor will fail to remain ON. Also find the maximum value of 'R' to ensure firing. **(06 Marks)**

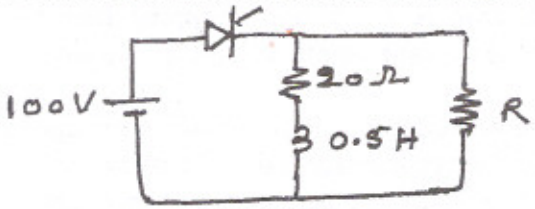

Fig. Q3(b)

c. With relevant circuit diagram and wave forms, explain the UJT relaxation oscillator. **(06 Marks)**

4 a. With a neat circuit diagram and wave forms explain the working of a single phase fully controlled converter with inductive load and continuous load current, also derive the expressions or average output voltage and rms output voltage. **(12 Marks)**

b. Give the comparison between circulating and non circulating current modes dual converter. **(05 Marks)**

c. What is the use of free wheeling diode in a converter circuit? **(03 Marks)**

PART – B

5 a. Explain the operation of impulse commutation with the relevant circuit diagram and waveforms. **(08 Marks)**

b. The commutation circuit for SCR by resonating load is shown in Fig. Q5(b). Verify whether the SCR will be self commutated or not. If the SCR is self commutated, calculate the voltage of the capacitor at the time of commutation. (Assume the initial conditions $V_C(0-) = I(0-) = 0$). **(08 Marks)**

V = 100 V
R = 10Ω
L = 10 mH
C = 10 μF

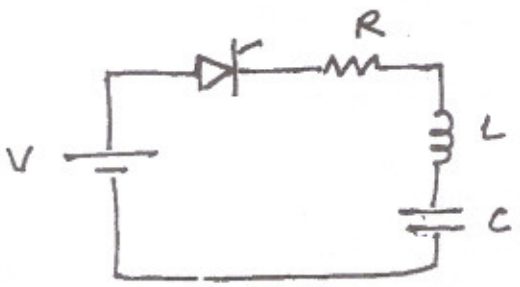

Fig. Q5(b)

c. State the conditions under which a load carrying thyristor can be successfully commutated. **(04 Marks)**

6 a. Draw the circuit diagram of a single phase AC voltage controller and explain the principle of ON-OFF control, with the help of relevant wave forms. Derive the expression for rms output voltage in terms of rms supply voltage and duty cycle of the operation of the controller. **(10 Marks)**

b. An AC voltage controller has a resistive load of 10Ω and rms input voltage 230V, 50Hz. The thyristor switch is ON for 25 cycles and OFF for 75 cycles. Determine
i) rms output voltage ii) input power factor. **(06 Marks)**

c. Distinguish between ON-OFF control and phase control of AC voltage controller. **(04 Marks)**

7 a. Explain the principle of operation of a step up chopper with suitable circuit diagram and waveforms. Derive the expression for average output voltage of step up chopper. **(10 Marks)**

b. Explain how the choppers are classified with reference to load voltage and load current. **(06 Marks)**

c. A DC chopper has a resistive load of 20Ω and input voltage 220V. When the chopper is ON its voltage drop is 1.5 V and chopping frequency is 10 KHz. If the duty cycle is 80% determine the average output voltage and rms output voltage. **(04 Marks)**

8 a. Explain the operation of single phase full bridge inverter with necessary circuit diagram and waveforms. Derive the expression for its rms value of output voltage. **(10 Marks)**

b. Explain the performance parameters of inverters. **(06 Marks)**

c. A single phase full bridge inverter has a resistive load of 2.4Ω and the DC input voltage of 48V. Determine
i) rms output voltage at the fundamental frequency
ii) output power. **(04 Marks)**

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2002 SCHEME

EE42

Fourth Semester B.E. Degree Examination, Dec.08 / Jan.09
Power Electronics

Time: 3 hrs. Max. Marks:100

Note :1. ***Answer any FIVE full questions.***
2. ***Missing data may be suitably assumed.***

1 a. Explain briefly the different types of power electronic circuits. **(05 Marks)**
b. Discuss peripheral effects of power electronics equipments. **(05 Marks)**
c. Explain turn-on and turn-off characteristics of SCR. **(10 Marks)**

2 a. Compare power MOSFETs and bipolar junction transistors. **(05 Marks)**
b. Draw and explain the dynamic characteristic of IGBT. **(05 Marks)**
c. For the BJT circuit shown in figure Q2 (c), if $V_{BE(sat)} = 1.5V$, $V_{CE(sat)} = 1.2V$, $\beta = 25$, $V_{CC} = 10V$, $R_C = 10\Omega$ and $R_B = 20\Omega$. Find i) Minimum voltage off V_{BB} required to ensure transistor saturation ii) On-state power loss in the transistor. **(05 Marks)**

d. Discuss methods of providing isolation of gate/base drive circuits from power circuits. **(05 Marks)**

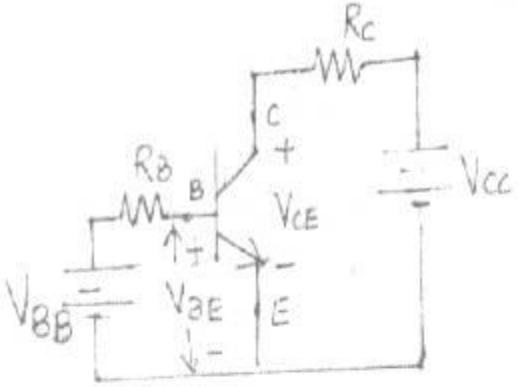


Fig. Q2 (c)

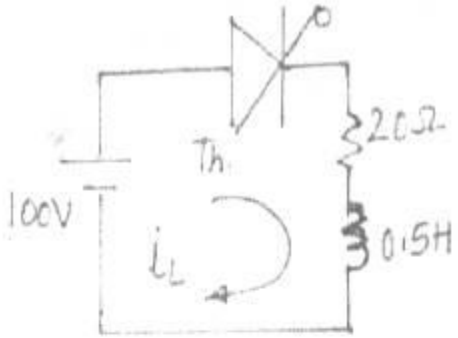
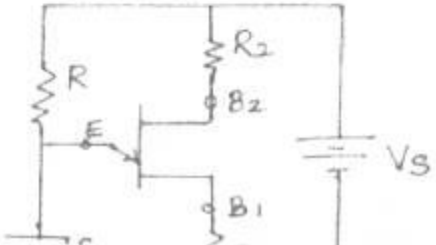


Fig. Q3 (b)

3 a. With two transistor model explain switching action of thyristor. Derive an expression for anode current. **(10 Marks)**
b. The thyristor in figure Q3 (b) has a latching current level of 50 mA and width of triggering pulse is 50 µsec. Find out whether the thyristor can be turned on successfully or not. **(04 Marks)**
c. Design UJT firing circuit shown in figure Q3 (c). The parameters of UJT are : $V_S = 20V$, $\eta = 0.66$, $I_p = 10\ \mu A$, $V_v = 2.5V$, $I_v = 10mA$. The frequency of oscillations is $f = 1$ kHz. The pulse width is $t_g = 40$ µsec. **(06 Marks)**



4 a. Distinguish between natural commutation and forced commutation. **(04 Marks)**

b. Commutation circuit for an SCR by resonating load is shown in figure Q4 (b). Check whether the SCR will be self commutated or not. If SCR is self commutated, calculate the voltage of the capacitor at the time of commutation. **(06 Marks)**

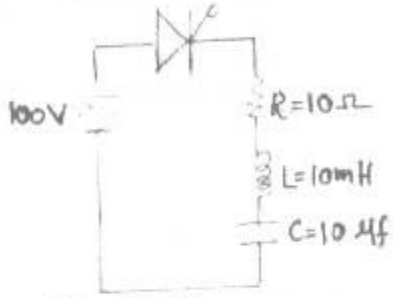


Fig. Q4 (b)

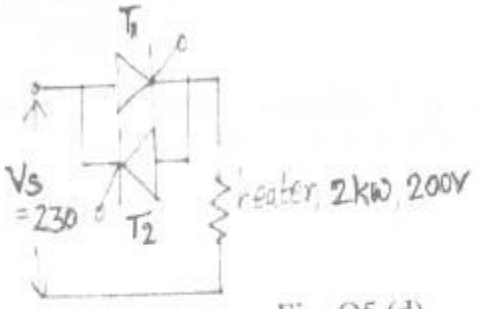


Fig. Q5 (d)

c. With neat circuit diagram and waveforms explain the working of complementary commutation. **(10 Marks)**

5 a. Draw the circuit of a single phase full wave AC voltage controller with "RL" load and sketch the output voltage and current and thyristor current waveforms. Derive expression for RMS output voltage. Also explain its operation. **(08 Marks)**

b. Distinguish between on-off control and phase control of AC voltage controllers. **(04 Marks)**

c. An on-off type of AC voltage controller is operating with a resistive load of R = 10Ω and the RMS supply voltage is 230 V. The controller remains on for 40 cycles and off 60 cycles. Determine i) RMS load voltage. ii) Input power factor. **(04 Marks)**

d. In the circuit of figure Q5 (d), if the load is 2 KW, 230 V, heater and $V_s = 230V$, 50 Hz. Calculate i) $V_{Load-rms}$ ii) Power dissipated in the heater for $\alpha = 45^\circ$. **(04 Marks)**

6 a. Explain with the help of waveforms, fully controlled single phase converter with "RL" load. **(08 Marks)**

b. A single phase half controlled rectifier is used to supply power to a load of 10Ω, from 230V, 50 Hz AC supply at firing angle 30°. Calculate: i) Average output voltage ii) effective output voltage iii) average load current. **(05 Marks)**

c. What is a freewheeling diode? What are the advantages of freewheeling diode in rectifier circuits feeding inductive load. **(03 Marks)**

d. Draw the circuit diagram of a single-phase dual converter. What are the advantages and disadvantages of circulating current mode dual converter? **(04 Marks)**

7 a. Explain how DC choppers are classified with reference to load voltage and load current. **(10 Marks)**

b. Write a short note on: step-up chopper. **(04 Marks)**

c. A DC chopper, of type A has a resistive load R = 20Ω and input voltage of 220 V. When chopper remains on, its voltage drop is $V_{Ch} = 1.5V$ and chopping frequency is 10 kHz? If duty cycle is 80%, determine i) Average output voltage ii) rms output voltage iii) chopper efficiency iv) effective input resistance Ri. **(06 Marks)**

8 a. With the necessary circuit diagram and waveforms. Explain the operation of single-phase half bridge inverter. **(06 Marks)**

b. Define the performance parameter of the inverters. **(04 Marks)**

c. With a circuit diagram explain the working of single-phase current source inverter. What are the advantages and disadvantages of current source inverter? (Note: CSI using **(08 Marks)**

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EC7T4

Seventh Semester B.E. Degree Examination, May / June 08
Power Electronics

Time: 3 hrs. Max. Marks:100

Note : ***Answer any FIVE full questions.***

1 a. With the help of block diagram, explain the operation of a Thyristorized power controller. List the classification of power controller mentioning atleast two applications of each. **(10 Marks)**

b. For a SCR, the gate cathode characteristics is given by a straight line with a gradient of 16 volts /ampere passing through the origin. The maximum turn on time is 4 ms and the minimum gate current required to obtain this quick turn on is 500 mA. If the gate source voltage is 115 V.

i) Calculate the resistance to be connected in series with the SCR gate

ii) Compute the gate power dissipation, given that the pulse width is equal to the turn on time and the average gate power dissipation is 0.3 w. Also compute the maximum triggering frequency that will be possible when pulse firing is used. **(10 Marks)**

2 a. Explain in detail the following ratings of SCR –

i) Average on state current

ii) RMS on state current

iii) I^2t rating

iv) Peak working reverse voltage

v) Repetitive peak reverse voltage. **(10 Marks)**

b. Design a UJT relaxation oscillator for triggering a SCR. The UJT has the following specifications. $\eta = 0.7$, $I_P = 50\ \mu A$, $V_V = 2$ V, $I_V = 6mA$, $V_{BB} = 20$ V, $R_{BB} = 7\ k\Omega$ and $I_{EC} = 2$ mA. Also determine the limits for the output frequency of the oscillator. **(10 Marks)**

3 a. With the help of a neat diagram and associated wave forms, explain the operation of a single phase semi converter with RL load. **(10 Marks)**

b. A single phase full converter has a RL load having L = 6.5 mH, R = 0.5 Ω and E = 10 V. The input voltage is $V = 120\sqrt{2}\ \sin 120\pi t$. Determine – i) the load current I_{LO} at $wt = \alpha = 60^0$ ii) the average thyristor current I_A iii) the rms thyristor current I_R iv) the rms output current I_{rms} and v) the average output current I_{dc}. **(10 Marks)**

4 a. With the help of a neat diagram and associated wave forms, explain the operation of a three phase semi converter. **(10 Marks)**

b. A 3 phase semi converter is operated from a 3 ϕ star connected 208 V, 60 Hz supply and the load resistance R = 10 Ω. If is required to obtain an average output voltage of 50% of the maximum possible output voltage, calculate – i) the delay angle α ii) the rms and average output current iii) the average and rms thyristor currents iv) the input power factor PF. **(10 Marks)**

a. What is commutation? Explain i) self commutation ii) impulse commutation. **(10 Marks)**

b. The resonant pulse commutation of Fig. Q 5(b) has capacitor C = 30 μf and inductance L = 4μH. The initial capacitor voltage is V_o = 200 V. Determine the circuit turn off time t_{off}, if the load current I_m is i) 250 A ii) 50 A.

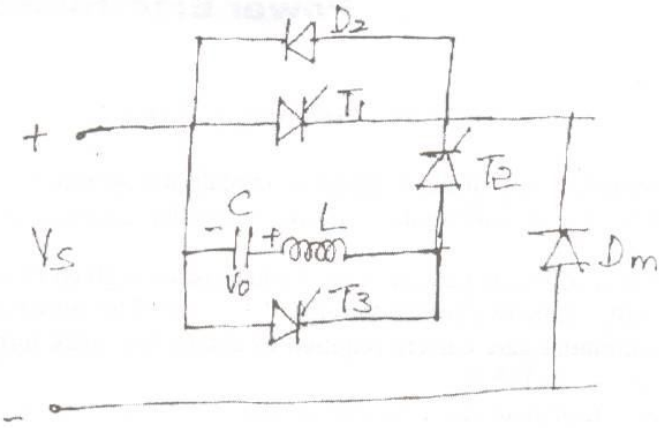

Fig. Q 5(b) **(10 Marks)**

a. Explain the principle of i) on – off control ii) phase control in an ac voltage controller. **(08 Marks)**

b. A single phase ac voltage controller has resistive load of R = 10 Ω and the input voltage is V_S = 120 V(rms), 60Hz. The delay angles of thyristors are equal $\alpha_1 = \alpha_2 = \pi/3$. Determine – i) the rms output voltage ii) the input power factor PF iii) the average current of the thyristors I_A iv) the rms current of the thyristors I_R. Also derive the voltage and current expressions mentioned above. **(12 Marks)**

a. What is a chopper? Explain the principle of operation of a step up chopper. **(08 Marks)**

b. A chopper is feeding a RL load as shown in Fig. Q 7(b) with V_S = 220 V, R = 10 Ω, L = 15.5 mH, f = 5 KHz and E = 20 V. Calculate – i) the minimum instantaneous load current I, ii) the peak instantaneous load current I_2, iii) the maximum peak to peak ripple current in the load iv) average load current I_a V) the rms load current I_o and vi) the rms value of the chopper current I_R.

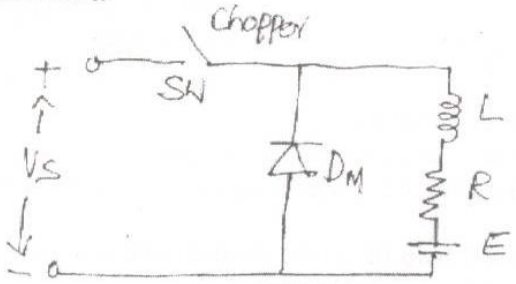

Fig. Q 7(b) **(12 Marks)**

a. With the help of a neat diagram and relevant wave forms describe the operation of a Boost regulator. **(10 Marks)**

b. Develop an expression for the closed loop transfer function of a separately excited dc motor. **(10 Marks)**

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EC7T4

Seventh Semester B.E. Degree Examination, Dec. 07 / Jan. 08
Power Electronics

Time: 3 hrs. Max. Marks:100

Note : ***Answer any FIVE full questions.***

1 a. What is a power controller? List the different types of power controllers, mentioning the function of each. **(06 Marks)**

b. What are the salient features of power MOSFET? Explain the switching times of power MOSFET. **(07 Marks)**

c. An SCR has a Vg – Ig characteristics given as Vg = 1.5 +8 Ig. In a certain application, the gate voltage consists of rectangular pulses of amplitude 12V and duration 50μs with duty cycle 0.2.

i) Determine the value of the series resistor Rg in the gate circuit to limit the peak power dissipation in the gate to 5 W.

ii) Calculate the average power dissipation in the gate. **(07 Marks)**

2 a. Explain the need to limit dv/dt and di/dt in a thyristor. **(06 Marks)**

b. Define the following for a thyristor :

i) Latching current ii) Turn – off time iii) Non – repetitive peak reverse voltage. **(06 Marks)**

c. Design a UJT relaxation oscillator firing circuit. The parameters of the UJT are V_s = 30V, η = 0.51, Ip = 10μ A, V_v = 3.5V and I_v = 10 m A. The frequency of oscillation is f = 60 Hz and the width of the triggering pulse is tg = 50μs. **(08 Marks)**

3 a. Explain the operation of a single phase semiconverter with a highly inductive load. Derive the expressions for V_{dc} and V_{rms}. **(10 Marks)**

b. A three phase half wave converter is operated from a three phase wye connected 220 V, 60 Hz supply and the load resistance R = 10Ω. If the average output voltage is 25% of the maximum possible average output voltage calculate :

i) The delay angle α, iii) The rectification efficiency

ii) The rms and average output currents iv) The input power factor. **(10 Marks)**

4 a. For a single phase full converter with inductive load assume the load current to be continuous and ripple free. Assume the transformer turns ratio to be unity. Express the input current in a fourier series and determine :

i) Harmonic factor of the input current ii)Displacement factor

ii) Input power factor. **(14 Marks)**

b. What are the advantages and disadvantage, of circulating current mode of operation of dual converters? **(06 Marks)**

5 a. What is forced commutation? With the help of neat circuit diagram and relevant waveforms explain the principle of operation of resonant pulse commutation circuit. **(12 Marks)**

b. In the circuit of Fig.5(b), $R_1 = R_2 = R = 5\Omega$, C = 10μF, V_s= 100V and $V_o = V_s$. determine the circuit turn – off time. Derive the expression used.

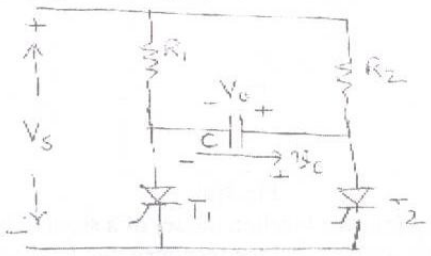

Fig. 5(b) **(08 Marks)**

2

6 a. With the help of a circuit diagram and associated waveforms explain the operation of a single phase bidirectional ac voltage controller with resistive load. Obtain the expression for the rms output voltage. **(10 Marks)**

b. The ac voltage controller in Fig.6(b) is used for heating a resistive load of R = 5Ω and the input voltage is V_s = 120V (rms) at 60 Hz. The thyristor switch is on for θ = 125^0 and is off for ϕ = 75^0. Determine : i)The rms output voltage V_o ii)The input power factor, PF iii)The average and rms thyristor currents.

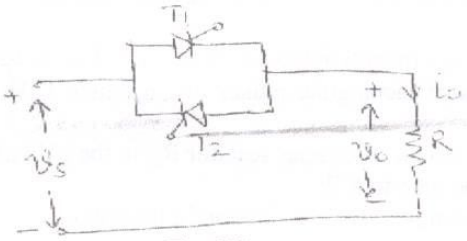

Fig.6(b) **(10 Marks)**

7 a. What is a step – down chopper? What are the disadvantages of variable frequency chopper? **(10 Marks)**

b. Deduce the constraints for the controllable transfer of energy between two dc voltage sources.

c. The chopper of Fig.7(c) has V_s = 220 V, R =10Ω, L = 15.5 mH, E = 20 V, K = 0.5 and f = 5 KHz calculate :

i) The minimum instantaneous load current, I_1
ii) The peak instantaneous load current, I_2
iii) The maximum peak to peak ripple current
iv)The average value of load current Ia
v) The rms load current Io
vi) The effective input resistance Ri as seen by the source.

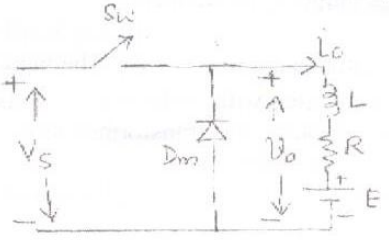

Fig.7(c) **(10 Marks)**

8 a. The Boost regulator of Fig. 8(a) has Vs = 5 V. The average output voltage is V_a = 15 V and the average load current I_a = 0.5 A. The switching frequency is 25 KHz. If L = 150μH and C =220μF determine : i)The duty cycle K ii) The ripple current of inductor ΔI iii) The peak current of inductor I_2 iv)The ripple voltage filter capacitor, ΔV_c

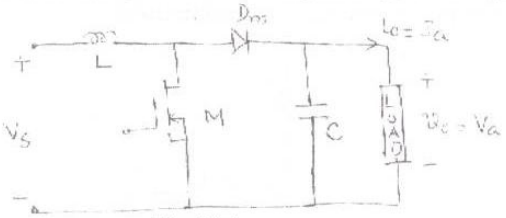

Fig.8(a) **(10 Marks)**

b. Develop the open – loop transfer function model of a separately excited DC motor. Explain how could this model be used to find the response due to changes in reference voltage and load torque. **(10 Marks)**

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OLD SCHEME

Seventh Semester B.E. Degree Examination, May 2007
Electronics and Communication Engineering
Power Electronics

Time: 3 hrs.] [Max. Marks:100

Note :1. ***Answer any FIVE full questions.***
2. Sketch neat diagrams and wave forms.

1 a. Draw the experimental set up to obtain the static anode VI characteristics of a unidirectional switching triode thyristor. Sketch the anode VI characteristics and explain the behaviour of the thyristor under different modes of operation with the help of 2 transistor analogy. **(07 Marks)**

b. Compare and distinguish between :
   i) SCR and Triac.
   ii) IGBT and MOSFET. **(08 Marks)**

c. In the DC gate triggering circuit shown in figure calculate
   i) The gate supply voltage V_{GG} required to turn on the SCR.
   ii) On state device anode current
   iii) Gate trigger input power
   iv) Device on state anode power dissipation
   v) Total device power dissipation, given that anode dc supply V_{AA} = 250 V, R_L = 100 Ω, R_G = 1 kΩ, V_{GT} = 1.5 V, I_{GT} = 10 mA. **(05 Marks)**

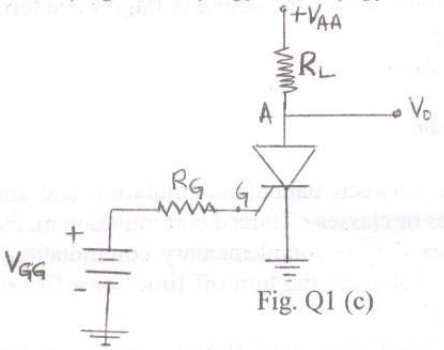

Fig. Q1 (c)

2 a. Draw neat sketches to illustrate the turn on and turn off characteristics of SCR and define the turn on and turn off times. Discuss the factors which affect the turn on and turn off times. **(07 Marks)**

b. Explain the importance of thyristor ratings and how they are classified. Sketch the gate trigger characteristics and indicate the relevant gate ratings and explain the use of gate trigger characteristics. **(07 Marks)**

c. Draw a line synchronized UJT pulse trigger circuit suitable to trigger the SCRs in a full wave phase controlled rectifier circuit. A zener diode with a break down voltage V_Z = 18 V, provides the supply for the UJT trigger circuit. The UJT used has η = 0.632. The series resistor R = 33 kΩ and capacitor C = 0.1 μF. The AC supply to the circuit is 25 volts RMS at 50 Hz. Sketch the relevant wave forms and calculate the trigger angle at which the SCR's are triggered. **(06 Marks)**

Contd...2

3 a. Draw the circuit of a single phase half controlled bridge converter feeding an R-L load with no FWD. Sketch the load voltage, load current, line current wave form for a trigger angle of 30° assuming the load inductance to be high. Explain its operation. Derive the expression for the average load voltage. **(10 Marks)**

b. A single phase fully controlled bridge converter is fed from AC supply of 230 volts RMS value at 50 Hz. The converter is used to charge a DC battery of 120 volts, having an internal resistance of 10 Ω. Sketch the output voltage and the load current wave forms and calculate the average battery charging current. Assume the trigger angle $\alpha = 45°$. **(10 Marks)**

4 a. Draw the circuit of a 3 phase half wave converter and write equations for the 3 phase supply voltages. Sketch the 3 phase supply voltages, load voltage, load current and thyristor current wave form assuming trigger angle $\alpha = 30°$. Derive the expression for the average output voltage. Assume RL load with a FWD connected across the load. **(10 Marks)**

b. With a neat circuit diagram and converter output wave form, explain a 3 phase dual convert system and its four quadrant operation. Differentiate between the circulating current mode and non circulating current mode. **(10 Marks)**

5 a. Explain the principle of ON – OFF control of an AC voltage controller, with suitable wave form and obtain an expression for the RMS output voltage and show how you would calculate the load power. **(08 Marks)**

b. A single phase full-wave AC voltage controller has a resistive load of 10 Ω and the input supply voltage is 230 V, 50 Hz AC supply. Delay angles of thyristors, $\alpha_1 = \alpha_2 = 30°$. Draw the circuit, sketch the output voltage wave form and calculate

i) RMS output voltage.
ii) Average thyristor current,
iii) Input power factor.

Derive the expressions used. **(12 Marks)**

6 a. Explain and differentiate between natural commutation and forced commutation. Mention the different types or classes of forced commutation methods. **(06 Marks)**

b. Explain the operation class-C type complementary commutation with a neat circuit diagram and wave forms. Calculate the turn off time for a DC supply of 200 volts, $R_1 = R_2 = 10\ \Omega$, $C = 4.7\ \mu F$. **(08 Marks)**

c. In the class-A type self commutation circuit shown in figure Q6 (c), calculate

i) The peak thyristor current that flows when the thyristor is triggered and
ii) Conduction time of thyristor.

Given that V = 300 V, C = 1 μF, L = 5 mH, R = 100 Ω **(06 Marks)**

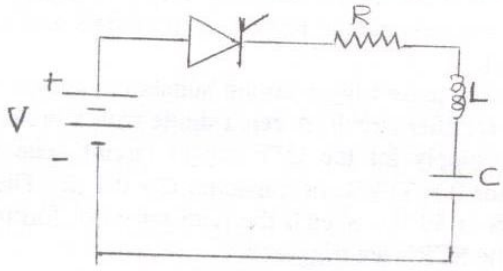

Fig. Q6 (c)

Contd....3

7 a. Explain the basic principle of a step down DC chopper with a simple ciruit and wave form. Obtain expression for the
   i) Average output voltage.
   ii) RMS output voltage.
   iii) Output power.
   iv) Effective input resistance. **(10 Marks)**

   b. A step down DC chopper supplies DC power to a DC motor load of 2 Ω having an inductance of 10 mH. The load is shunted by a FWD. Sketch the output load voltage and current wave forms. What is the ratio of chopper ON time to the period. When the chopper is operating at a frequency of 200 Hz, the mean value of the load current measured is 10 A and the DC supply voltage is 200 V. Determine the ON/OFF ratio of the chopper. Write down the equations for the load current during
   i) Chopper ON time and
   ii) Chopper OFF time and hence calculate the maximum and the minimum value of the load current. **(10 Marks)**

8 a. Explain the different classes of choppers with suitable diagram. **(10 Marks)**

   b. With a neat circuit diagram and relevant wave form describe the operation of a Buck regulator for continuous inductor current flow. **(10 Marks)**

1 Paper
1 Sheet

EC7T4

USN

OLD SCHEME

Seventh Semester B.E. Degree Examination, May / June 2006
Electronics and Communication Engineering
Power Electronics

Time: 3 hrs.] [Max. Marks:100

Note: 1. *Answer any FIVE full question.*
2. *Assume any missing data.*
3. *All questions carry equal marks.*

1 a. Explain in brief the Dynamic characteristics of an SCR. **(06 Marks)**

b. Discuss the V-I Characteristic of the triac. Mention a few applications of MOSFET. **(08 Marks)**

c. Design the values of di/dt inductor and R_c snubber components for an SCR working in a 230V system. Given di/dt rating is $90^A/\mu s$ and dv/dt rating is $200V/\mu s$. Effective series resistance is 1.5Ω. Take damping factor as 0.6. **(06 Marks)**

2 a. Mention important features of firing circuit. Explain the UJT triggering circuit with its wave forms. **(08 Marks)**

b. List the classifications of power controllers. Mention at least two applications of each. **(06 Marks)**

c. Design the UJT triggering circuit for SCR, Given V_{BB}=20V, η=0.6, I_P=10μA, V_V = 2V, I_V = 10mA. The frequency of oscillation is 100 Hz, the triggering pulse width should be $50\mu s$. **(06 Marks)**

3 a. With the help of a neat diagram describe the operation of a single phase half controlled-rectifier assuming continuous current operation. Draw the associated wave forms. Derive expressions for average and rms out put voltages. **(10 Marks)**

b. The Semi converter with RLE and flywheel diode is connected to a 120V, 60Hz supply. The load current Ia can be assumed to be continuous and its ripple content is negligible. The turns ratio of the transformer is unity. If the delay angle $\alpha = \frac{\pi}{2}$, calculate V_{dc}, V_{rms}, HF, DF and PF. **(10 Marks)**

4 a. Explain with neat sketch and associated wave forms the operation of single-phase dual converter. **(10 Marks)**

b. A three phase semi converter is operated from a three phase Y-connected 208V, 60Hz supply and the load resistance is $R=10\Omega$. If it is required to obtain an average output voltage of 50% of the maximum possible output voltage, calculate i) the delay angle α ii) the rms and average output currents iii) the average and rms thyrister currents iv) the input power factor v) the rectification efficiency vi) the transformer utilization factor TUF. **(10 Marks)**

Contd...2

5 a. Explain the principle of operation of a Resonat pulse commutation with its associated wave forms and mathematical analysis. **(12 Marks)**

b. For the impulse commutation circuit shown in figure 5(b), V_s=220V, C=20 μF and R=10Ω. Determine the turn-off time t_{off} and also derive the formula used. Take initial voltage on capacitor $V_c(t)=-V_s$

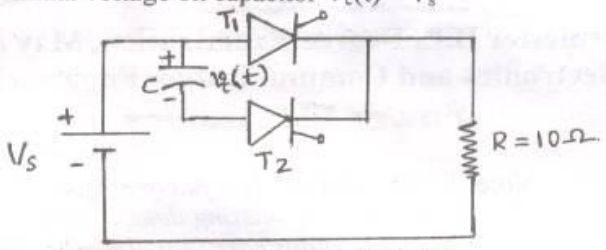

fig 5 (b) **(08 Marks)**

6 a. With relevant wave form explain the working of a single phase full-wave AC voltage controller with resistive load. Derive the expression for rms output voltage. **(10 Marks)**

b. A single-phase full wave AC voltage controller is used to control the power from a 230V AC source into a resistive load that can vary from 1.15 to 2.30Ω. The maximum output desired is 2300kw. Calculate
i) The maximum value of thyrister voltage ii) The rms thyrister current IR
iii) The average thyrister current I_A **(10 Marks)**

7 a. With the help of neat diagram and associated wave forms describe the operation of step-down chopper with RL-load. **(10 Marks)**

b. For a chopper shown in figure 7 (b) DC source voltage is 230V, load resistance is 10Ω, consider the voltage drop of 2V across chopper when it is on. For a duty cycle of 0.4.
Calculate i) Average value of output voltage ii) RMS value of output voltage
iii) Chopper efficiency

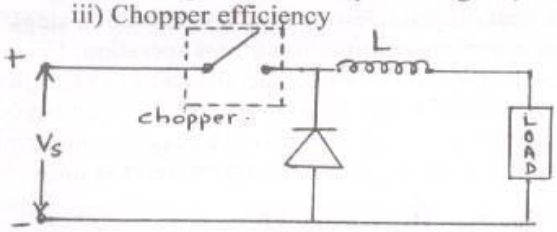

Fig 7(b) **(10 Marks)**

8 a. With the help of diagram and associated wave forms describe the operation of a BOOST regulator. **(10 Marks)**

b. What is the principle of closed loop control of DC drives? Mention its advantages. **(10 Marks)**

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Seventh Semester B.E. Degree Examination, January/February 2005

Electronics & Communication Engineering

Power Electronics

Time: 3 hrs.] [Max.Marks : 100

Note: *Answer any FIVE full questions.*

1. (a) Explain the TURNON and TURNOFF characteristic of MOSFET. (8 Marks)

   (b) List the merits and demerits of IGBT. (4 Marks)

   (c) Explain the TURNON and TURNOFF characteristics of SCR. (8 Marks)

2. (a) Explain the Gate triggering characteristics of SCR. (6 Marks)

   (b) A SCR with latencing current if 100mA is connected in series with a resistance of 10Ω and inductance of 1 Henry. DC voltage source = 207v. Calculate the minimum gate pulse width to turn on SCR. (4 Marks)

   (c) Discuss the SCR ratings listed below:

   i) Average and RMS current rating

   ii) I^2t rating

   iii) $\frac{dv}{dt}$ rating

   iv) Peak off state blocking voltage V_{Dkm}

   v) Forword static $\frac{dv}{dt}$ rating (10 Marks)

3. (a) For a single phase semiconverter with resistive load, derive the expression for the following & draw relevant wave forms for analysis

   i) Average load voltage and R.M.S load voltage

   ii) Normalised average voltage and form factor

   iii) Ripple factor and rectifier (η) efficiency. (12 Marks)

   (b) A 3ϕ half wave controlled rectifier is operated on 3ϕ ac supply with an r.m.s phase voltage of 230V, load resistance = 10Ω, f = 50Hz. The average o/p voltage must be 40% of the maximum possible o/p voltage. Calculate

   i) Delay angle ii) RMS and average load current

   iii) R.M.S and average thyristor current. (8 Marks)

4. (a) With the help of a neat diagram and associated waveforms describe the operation of a single phase dual converter. (10 Marks)

   (b) Explain with the help of a diagram and associated wave form the working of impulse commutated circuit with accelerated recharging. Derive ane expression

5. (a) Discuss normal commutation and forced commutation. (4 Marks)

   (b) What are the advantages and disadvantages of ON-OFF control used in ac voltage controllers? (6 Marks)

   (c) Draw the circuit diagram of a single phase full wave AC voltage controller with RL load and sketch the O/p voltage and load current and thyristor current wave forms. Derive the expression for the RMS O/P voltage. (10 Marks)

6. (a) Explain how the choppers are classified.

   (b) Explain the principle of operation of

   i) step down chopper

   ii) step up chopper (10 Marks)

7. (a) Explain the working of buck regulator with relevant wave forms and circuit diagram. Prove that

   $$\Delta VC = \frac{Vs\ k(1-k)}{sLCf^2}$$

   where V_s supply voltage k- duty cycle. (10 Marks)

   (b) Develop an expression for open loop transfer function of a saperately excited DC motor. (10 Marks)

8. (a) Using two transistor equivalent circuit derive an expression for anode current in SCR. (6 Marks)

   (b) Show that for 3ϕ full converter

   i) $V_{dc} = \frac{3\sqrt{3}Vm}{\pi} cos\alpha$ ii) $V_{rms} = \sqrt{3}V_m[\frac{1}{2} + \frac{3\sqrt{3}}{4\pi} cos\ 2\ \alpha]^{\frac{1}{2}}$. (8 Marks)

   (c) Discuss the working of a switched mode regulator. (6 Marks)

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