NEW SCHEME

EC42

USN | | | | | | | | | | |

Fourth Semester B.E. Degree Examination, July/August 2004

BM/EC/EE/TE/ML/IT

Power Electronics

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

Note: ***1) Answer any FIVE full questions.***
2) All questions carry equal marks

1. (a) With circuit diagrams and waveforms of control signal and output voltage, explain the control characteristics of S.C.R and MOSFET. **(8 Marks)**

(b) List the major types of power electronic circuits and mention in each case, the type of input supply given and the output we get. **(6 Marks)**

(c) Sketch the output characteristics of enhancement type MOSFET. What are the basic differences in control of BJT and MOSFET? **(6 Marks)**

2. (a) With a circuit diagram, explain 'antisaturation control' of BJT. Mention the improvement and drawback of this arrangement. **(6 Marks)**

(b) Discuss methods for providing isolation of gate/ base circuits from power circuit, with circuit diagrams. **(8 Marks)**

(c) For the transistor switch of Fig. Qn. 2c,

i) Calculate forced beta, β_f of transistor

ii) If the manufacturer's specified β is in the range 8 to 40, calculate the minimum overdrive factor (ODF).

iii) Obtain power loss P_T in the transistor.

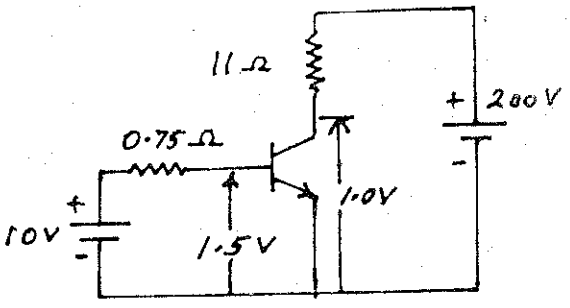

FIG. Qn. 2c **(6 Marks)**

3. (a) Using two transistor model, explain how a small gate current can turn ON a S.C.R. when blocking forward voltage. **(6 Marks)**

(b) With circuit diagram and waveforms, discuss the operation of R-C firing circuit for a half wave S.C.R. controlled rectifier. **(8 Marks)**

(c) How many S.C.R's are required in a series string to withstand a.d.c voltage of 3500 volts in steady state, if the S.C.Rs have steady state voltage rating

Contd.... 2

of 1000V and the steady state derating factor is 30%? Assuming maximum difference in leakage current of S.C.Rs to be 10mA, calculate the value of voltage sharing resistances to be used. Draw the circuit showing the S.C.R.s and the voltage sharing resistances. **(6 Marks)**

4. (a) Distinguish between natural commutation and forced commutation for S.C.R with illustrative examples. **(6 Marks)**

(b) With a circuit diagram and waveforms, explain the principle of self commutation of an S.C.R. Write down the general expression for your circuit when S.C.R is turned ON in a series L, C circuit with a d.c. supply voltage V_s and give the expression for i(t). State the initial conditions assumed. What is the conduction time (commutation time) of the S.C.R.? **(10 Marks)**

(c) A complementary commutation circuit as shown in FIG. Qn 4c has two S.C.Rs with specified minimum turn off time, t_{off} equal to $50\mu s$. Make necessary calculations and state whether the circuit components are correct for satisfactory commutation of S.C.Rs

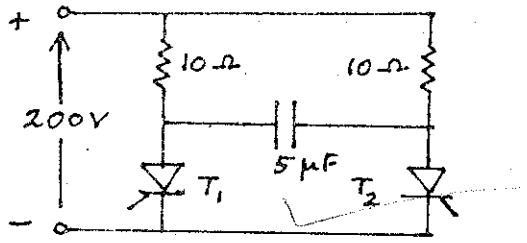

FIG. Qn.4.c

(4 Marks)

5. (a) For a.c voltage control, discuss the difference in performance between single phase unidirectional controller and bidirectional controller for a resistive load with circuit diagrams and output voltage waveforms. **(6 Marks)**

(b) With a circuit diagram and waveforms of gating pulses and output voltage, explain the operation of a single phase ON-OFF type a.c voltage controller. Define duty cycle k and derive an expression for r.m.s output voltage. What are the applications for this method? **(10 Marks)**

(c) A circuit of the above type with an input of 230V, 50Hz is connected to a resistive load of 20 ohms. The circuit is operating with the switch ON for 30 cycles and OFF for 30 cycles.

Determine :

i) r.m.s. output current and

ii) input power factor. **(4 Marks)**

6. (a) Show the circuit diagram of a single phase semiconvertor and explain the operation, assuming constant load current. Sketch waveforms of output voltage and current in one S.C.R for a firing angle, $\alpha = 45^0$. **(10 Marks)**

(b) With circuit diagram, explain the operation of a three phase full converter for constant load current. If the input to this circuit is 3 phase, 50Hz a.c supply, determine the firing angle, α, for the S.C.R.S to obtain an output average d.c voltage of 50% of the maximum. If this output voltage is 270 volts, calculate a.c. supply line to line r.m.s voltage. **(10 Marks)**

Contd.... 3

7. (a) With circuit diagram, equivalent circuits and waveforms of load voltage and load current, discuss the operation of a step down d.c chopper with R-L load. Distinguish between continuous and discontinuous current modes of operation. **(10 Marks)**

(b) Draw the schematic circuit of a class E four quadrant d.C. chopper and mention the devices that provide the path for current in the first and third quadrants of operation. **(6 Marks)**

(c) Considering the switch to be ideal in the circuit of Fig. Qn. 7c, determine :

i) the duty cycle, k for which the output average d.c. voltage and r.m.s voltage are equal

ii) the chopper efficiency.

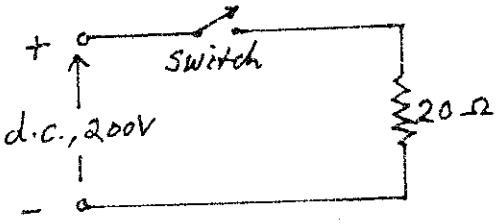

FIG. Qn. 7c

(4 Marks)

8. (a) With circuit diagram of a half bridge transistor inverter, explain the operation. Sketch waveforms of output voltage and current in devices, for a resistive load. Derive an expression for output r.m.s voltage. If your circuit uses additional diodes, what is their function? **(10 Marks)**

(b) Considering a single phase bridge inverter, explain the phase displacement method of output voltage control. If the d.c input voltage is 200 volts and the required r.m.s fundamental output voltage is 90 volts, determine the delay angle, β. **(10 Marks)**

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EC42

NEW SCHEME

USN

Fourth Semester B.E. Degree Examination, July/August 2005

EC/TE/BM/ML/EE/IT

Power Electronics

[Max.Marks : 100

Time: 3 hrs.]

Note: *1) Answer any FIVE full questions.*
2) All questions carry equal marks

1. (a) Explain the turn-on and turn off characteristics of the SCR. **(8 Marks)**

(b) A thyristor has a forward characteristic which may be approximated by a straight line shown in the following figure. Calculate the mean power loss for

i) a continuous on state current of 23 A.

ii) a half sine wave of mean value 18A

iii) A level current of 39.6A for one half cycle. **(6 Marks)**

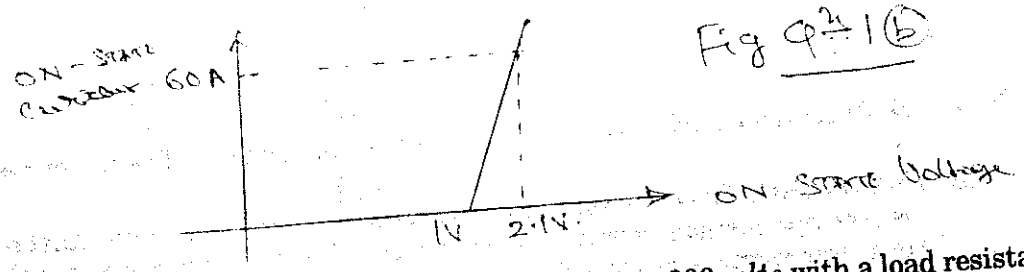

Fig Q1(b)

(c) The input voltage to circuit shown below is $V_s = 200volts$ with a load resistance of $R = 10\Omega$ and a load inductance of $L = 50\mu H$. If the damping ratio is 0.7 and discharging current of capacitor is 5A, determine :

i) the values of R_s & C_s **(6 Marks)**

ii) Maximum $\frac{dv}{dt}$

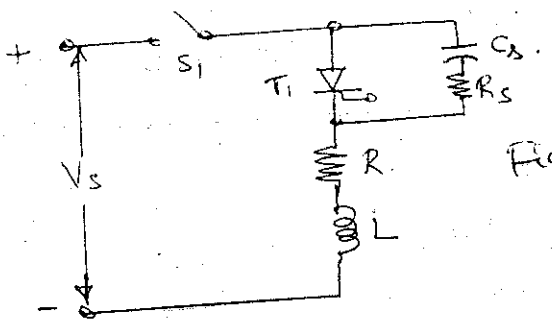

Fig Q1(c)

2. (a) List the different types of power electric circuits. **(4 Marks)**

(b) Describe briefly the various base drive control methods used in Juverion transistors. **(10 Marks)**

Contd.... 2

(c) In the circuit shown the BJT is acting as a chopper switch at a frequency of 15 KHz. E_{DC}=240V and load current is 100 Amps. The switching times are $t_d = 0$, $t_r = 1.5\mu sec$ and $t_f = 0.7\mu sec$. Calculate the values of

i) L_s and C_s

ii) R_s for critically damped conditions

iii) R_s if the discharge current is limited to 5% of load current

iv) Power loss due to snubber neglecting effect of inductor L_s on voltage of C_s. Assume that $V_{ce(sat)} = 0$.

(6 Marks)

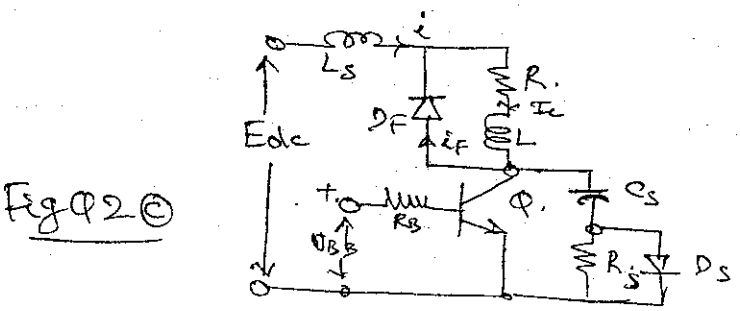

Fig Q2 (c)

3. (a) Distinguish clearly between natural commudation and forced commutation.

(8 Marks)

(b) With the help of a neat diagram and associated waveforms, explain the operation of a complementary commutation circuit. Derive an expression for the turn-off time assuming a resistive load.

(8 Marks)

(c) For the commutation circuit shown in the following figure, $C = 20\mu F$ and $L_1 = 25\mu H$. The initial capacitor voltage is equal to input voltage i.e., $V_o = V_s = 200$ volts. If the load current I_m varies between 50A and 200 A, determine the variations in circuit turn-off. Derive any formulae you use.

(10 Marks)

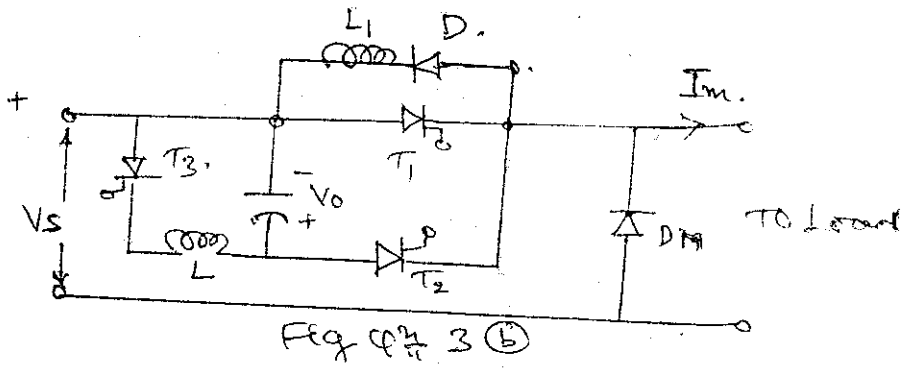

Fig Q No 3 (b)

4. (a) Compare and contrast on-off control with phase control as applied to AC voltage controllers. **(6 Marks)**

(b) A single phase half wave AC voltage controller shown in the following figure feeds power to a resistive load of 6Ω from 230V, 50Hz source. The firing angle of SCR is $\alpha = \frac{\pi}{2}$. Calculate :

i) Rms value of output voltage

ii) Input power factor

iii) Average input current. Derive any formulae you use for atleast two subdivisions. **(10 Marks)**

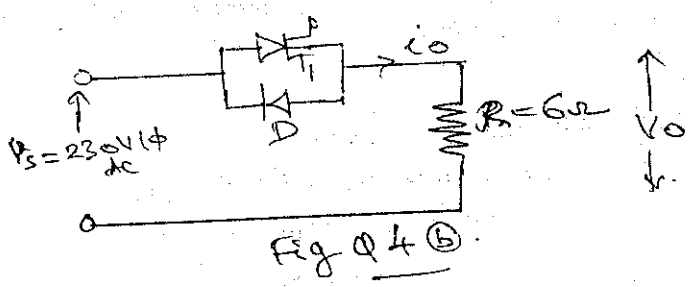

Fig Q4 (b)

(c) Explain why short duration pulses are not suitable for AC voltage controller with inductive loads. **(4 Marks)**

5. (a) A three phase fully controlled converter is operating with a highly inductive load. The load current is continuous and ripple free equal to Io Determine :

i) Rms supply current ii) Displacement factor
iii) Distortion factor iv) Power factor
v) Harmonic factor. **(10 Marks)**

(b) A single phase half wave rectifier has a transformer secondary voltage of 230 volts, 50 Hz and supplies a purely resistive load of $R = 1\Omega$. If the average output voltage is 25% of the maximum possible value of DC output voltage. Calculate : **(10 Marks)**

i) Delay angle of thyristor

ii) Rms and average value of output current

iii) Rms and average volume of thyrisor current

iv) Input power factor. **(10 Marks)**

6. (a) Explain in detail how choppers are classified.

(b) For an ideal type class A chopper circuit $V_s = 220volts$, $R = 5\Omega$, $L = 7.5mH$, $f = 1KHz$ and $E = 0$. Duty cycle $K = 0.5$. Calculate :

i) I_{min} & I_{max}

ii) ΔI i.e., peak to peak ripple current.

iii) Average and Rms value of load current.

iv) Effective input resistance of chopper.

v) Rms chopper current. **(10 Marks)**

Contd.... 4

7. (a) Define the performance parameter and inverters. **(4 Marks)**

(b) With necessary waveforms explain the operation of a single phase half-bridge inverter. **(10 Marks)**

(c) For a type A chopper circuit, $E_{dc} = 220V$, $f = 500Hz$. Duty cycle $k = 0.3$ and load $R = 1\Omega$, $L = 3mH$ and $E = 23$ Volts. Compare the following quantities.

i) Check whether the conversion is continuous or not.

ii) Average o/p current

iii) I_{max} & I_{min} **(6 Marks)**

8. (a) With the help of a neat diagram and associated w/F's, explain the operation of a three phase inverter employing 120^0 conduction strategy. **(10 Marks)**

(b) Explain :

i) Phase displacement technique.

ii) Multiple pulse width modulation technique.

used for controlling the output voltage of a single phase inverter. **(10 Marks)**

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NEW SCHEME

Reg. No. | | | | | | | | | |

Fourth Semester B.E. Degree Examination, January/February 2006

EC/TE/BM/ML/EE/IT

Power Electronics

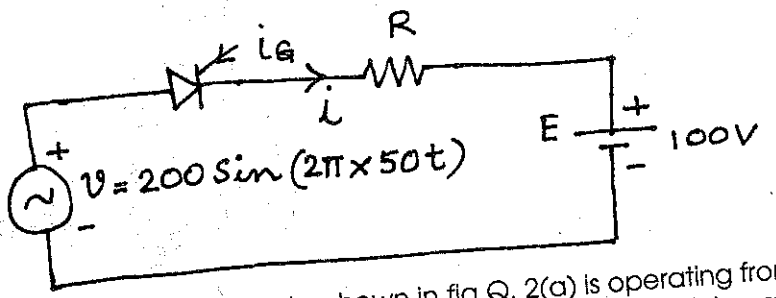
Time: 3 hrs.) (Max.Marks : 100

Note: *1. Answer any FIVE full questions from the following.*
2. All questions carry equal marks
3. Justify any assumptions made.

1. (a) What is a power converter ? List the different types of power converters and mention their conversion functions. **(7 Marks)**

(b) What are the peripheral effects of power electronic circuits ? What are the remedies for them ? **(5 Marks)**

(c) The thyristor shown in the circuit of Fig Q. 1(c) is triggered by a dc signal applied to the gate. Calculate i) the average value of current i, ii) power loss in the resistor. **(8 Marks)**

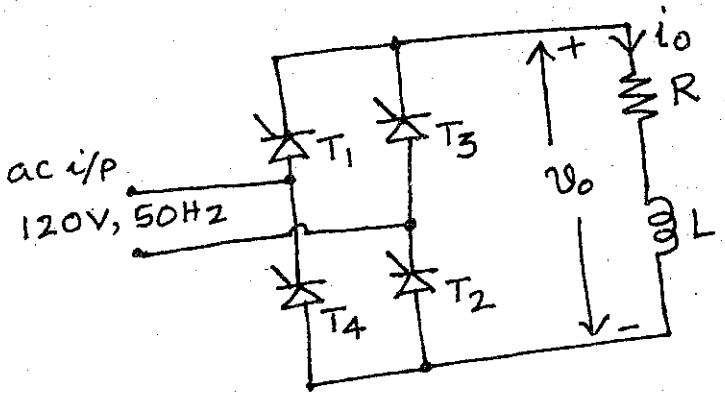


2. (a) The single phase full converter shown in fig Q. 2(a) is operating from a $120V, 50Hz$ supply and provides an average load current of 5A at a delay angle of $\alpha = 30^0$. If the ripple content of the load current is negligible, calculate

i) dc load voltage and dc output power

ii) the quantities mentioned in (i) if a freewheeling diode is connected across the output for the same load resistance and delay angle and

iii) the dc load voltage and current if thyristor T_3 is open circuited. Assume same load resistance and firing angle and a freewheeling diode across the load. **(10 Marks)**



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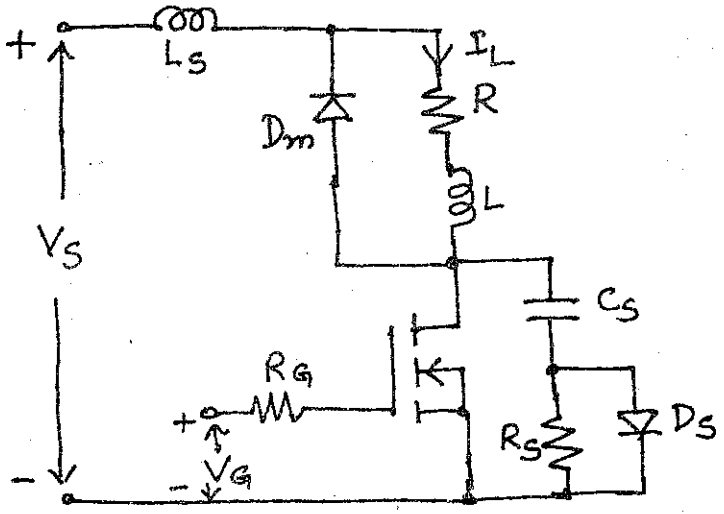
(b) Draw the circuit diagram of a single phase dual converter with RL load. Sketch the waveforms of input voltage, output voltage of converter 1, output voltage of converter 2 and voltage across the circulating inductor. Assume $\alpha = 60^0$. Mention any two advantages of circulating current mode of operation of dual converters.
(10 Marks)

3. (a) Explain how antisaturation base control improves the switching performance of a BJT.
(6 Marks)

(b) With the help of switching waveforms explain the switching times of a power MOSFET.
(7 Marks)

(c) A MOSFET is operated as a chopper switch at a frequency of $f_s = 50kHz$. The circuit arrangement is shown in fig Q 3(c). The dc input voltage of the chopper is $V_s = 30V$ and the load current is $I_l = 40A$. The switching times are $t_r = 60ns$ and $t_f = 25ns$.

Determine the values of i) L_s, ii) C_s, iii) R_s for critically damped condition and iv) R_s if peak discharge current is limited to 5% of load current. **(7 Marks)**



4. (a) Distinguish between :

i) Latching current and holding current of a thyristor

ii) Converter grade and inverter grade thyristors.
(4 Marks)

(b) Define turn -off time of thyristor and mention any two factors that affect it.
(3 Marks)

(c) Ten thyristors are used in a string to withstand a dc voltage of $V_S = 15kV$. The maximum leakage current and recovery charge differences of thyristors are $10mA$ and $150\mu C$ respectively. Each thyristor has a voltage sharing resistance of $R = 56k\Omega$ and capacitance of $C_1 = 0.5\mu F$. Determine

i) the maximum steady state voltage sharing $V_{DS}(max)$,

ii) the steady state voltage derating factor,

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

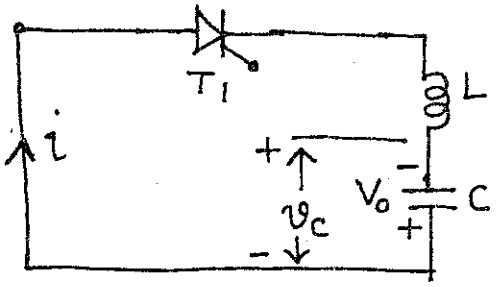
iv) The transient voltage derating factor.
(8 Marks)

(d) Briefly explain RC triggering circuit for full wave control.
(5 Marks)

5. (a) What do you mean by commutation ? What are the conditions to be satisfied for commutation of a thyristor ?
(4 Marks)

Contd.... 3

(b) In fig Q 5(b) the initial capacitor voltage $V_0 = 500V$, capacitance $C = 25\mu F$ and inductance $L = 10\mu H$. Determine the peak value of resonant current and the conduction time of thyristor T_1. Derive the expressions used. **(8 Marks)**



(c) With the help of a neat circuit diagram and relevant waveforms explain the operation of a complementary commutation circuit. **(8 Marks)**

6. (a) Mention the advantages and disadvantages of on-off control method of ac voltage control. **(3 Marks)**

(b) A singe phase full wave ac voltage controller using two thyristors in antiparallel has a resistive load of $R = 1.5\Omega$ and the input voltage is $120V(rms), 50Hz$. IF the desired output power is $P_0 = 4.53kW$ determine
i) the delay angles of the thyristors T_1 and T_2,
ii) the rms output voltage and output current,
iii) the input power factor, PF and
iv) the rms current of each thyristor. **(11 Marks)**

(c) Explain why short duration single gate pulses are not suitable for triggering thyristors in a full wave ac voltage controller with inductive loads. **(6 Marks)**

7. (a) With the help of a neat circuit diagram explain the principle of working of a step - down chopper. **(6 Marks)**

(b) In a step - down chopper, the source voltage is $220V$ dc. The load circuit parameters and $R = 10\Omega$ and $L = 5mH$. If the chopper is operating at a frequency of $200Hz$ and the ON/OFF ratio of the chopper is 2 : 1 calculate

i) the average load current,

ii) the maximum and minimum values of instantaneous load current under steady state conditions. **(7 Marks)**

(c) Explain how the principle of step-up chopper can be used to transfer energy from a low voltage dc source to a high voltage dc source. **(7 Marks)**

8. (a) A single phase full bridge inverter has a resistive load of $R = 10\Omega$ and the dc input voltage is $V_s = 220V$. Calculate i) the rms output voltage at the fundamental frequency, V_1, ii) the average rms and peak currents of each transistor switch, iii) the output power, P_0 and iv) the peak off-state voltage of each transistor, V_{BR}. **(6 Marks)**

(b) Draw the circuit diagram of a three phase bridge inverter with wye connected resistive load. Sketch the gating signals and line to line output voltages for 180^0 conduction operation. **(7 Marks)**

(c) With the help of neat waveforms explain the principle of multiple pulse width modulation method of output voltage control in a single phase inverter. Write the expression for the rms output voltage. **(7 Marks)**

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EC42

USN

NEW SCHEME

Fourth Semester B.E. Degree Examination, July 2006
EC/EE/IT/TC/ML/BM
Power Electronics

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

Note: *1. Answer any FIVE full questions.*

1 a. What are the advantages of static power converters? Mention the peripheral (terminal) effects of such static power converters. **(06 Marks)**

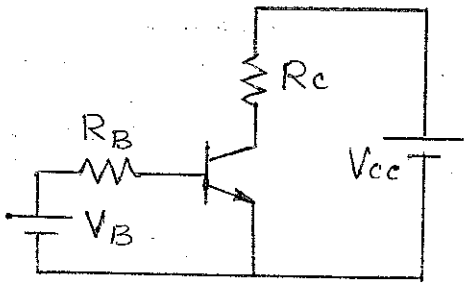
b. Mention at least four power electronic circuits; indicate their inputs and outputs with one application of each type. **(06 Marks)**

c. Draw the input and output characteristics of four of the following devices: i) BJT ii) MOSFET iii) IGBT iv) SCR v) UJT. **(08 Marks)**

2 a. Compare BJT, MOSFET and SCR with reference to power switching applications. **(06 Marks)**

b. Draw the switching model and switching wave-forms of a power MOSFET. Define the different switching times. **(06 Marks)**

c. A power BJT is connected as a switch as in fig.2(c) with the following data:



V_{CC}=100V, V_B=8V, $V_{CE(sat)}$=2.5V, $V_{BE(sat)}$=1.75V
β of the thermistor is varied from 10 to 60.

Fig.2(c)

Calculate: i) the value of R_B that will result in saturation with an over drive factor of 20. ii) the forced β. iii) power loss in the transistor. **(08 Marks)**

3 a. Using two transistor model, explain the turn-on mechanism of a SCR. Derive an expression for anode current interms of transistor parameters. **(08 Marks)**

b. Explain the need for dv/dt and di/dt protection for SCR. A SCR circuit has the following data: supply voltage = 200 V, dv/dt rating = 100 $V/\mu s$, di/dt rating = 50 $A/\mu s$. Calculate the Snubber circuit elements using approximate expressions. **(08 Marks)**

c. With a circuit diagram and waveforms explain RC – triggering circuit. **(04 Marks)**

4 a. What are the conditions to be satisfied for successful commutation of a thyristor? With voltage and current wave forms, discuss the process of commutation. **(06 Marks)**

b. With the help of a circuit diagram and waveforms explain the operation of resonant pulse commutation. **(08 Marks)**

c. For the complementary commutation circuit shown in fig.4(c). Calculate the values of C to provide circuit turn off time of 20 micro-sec. **(06 Marks)**

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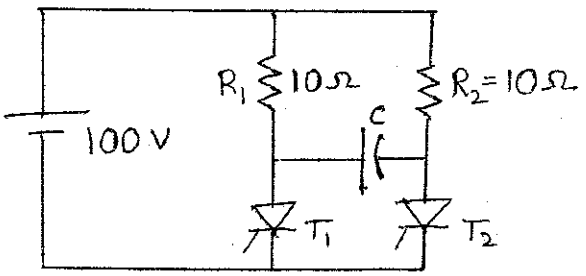

Fig.4(c)

5 a. Explain with a circuit diagram and waveforms the working of a single phase control type AC voltage controller connected to resistive load. Derive the relationship between rms output voltage and rms input voltage. **(08 Marks)**

b. Why short duration gate pulses are not suited for triggering thyristors in full wave a.c. voltage controllers feeding inductive loads. **(04 Marks)**

c. A single phase full wave a.c. voltage controller shown in fig.5(c) has a resistive load of 5 Ohm with input voltage of 120 V, 50 Hz. The delay angles $\alpha_1 = \alpha_2 = 2\pi/3$.

Determine : i) rms output voltage ii) average current through the thyristors. iii) rms current through the thyristors iv) input P.F. **(08 Marks)**

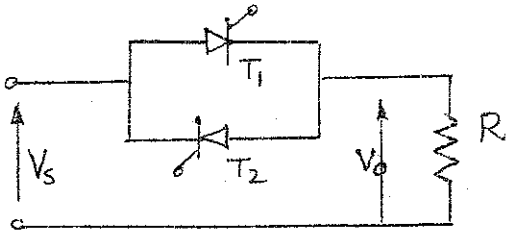

Fig.5(c)

6 a. Explain the working of a single phase full converter feeding highly inductive load. Derive an expression for average output voltage. **(08 Marks)**

b. What is a free Wheeling Diode? What are the advantages of free Wheeling Diode in rectifier circuits feeding inductive load? **(04 Marks)**

c. A single phase dual converter is feeding RL load, the thyristors are triggered with a delay angle of 60 degrees. Sketch the waveforms of input voltage, and output voltage of both the converters. Mention any two advantages of circulating current mode of operation of dual converter. **(08 Marks)**

7 a. Explain how DC choppers are classified, with reference to load voltage and load current. **(08 Marks)**

b. With the help of a circuit diagram and waveforms explain the working of a DC chopper. Derive an expression for:
i) Output voltage ii) Output power **(12 Marks)**

8 a. With circuit diagram and waveforms explain the operation of a single phase bridge inverter feeding resistive load. If additional diodes are connected across the switches, what are their functions? **(08 Marks)**

b. Briefly explain how output is controlled in single phase bridge inverter. **(04 Marks)**

c. With a circuit diagram explain the working of a single phase current source inverter. **(08 Marks)**

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EC42

USN | | | | | | | | | | |

NEW SCHEME

Fourth Semester B.E. Degree Examination, Dec.06 / Jan.07
Electronics and Communication Engineering
Power Electronics

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

Note: ***1. Answer any FIVE full questions.***

1 a. Give a list of Power Electronic circuits for different input / output requirements. **(05 Marks)**

b. Discuss the peripheral effects of Power Electronics equipments. **(05 Marks)**

c. With model and waveforms, explain how the internal capacitances of the transistor influence the switching characteristics of the transistor. **(10 Marks)**

2 a. Explain the anti saturation control technique used to improve the switching speed of a power B.J.T. **(06 Marks)**

b. Discuss methods of providing isolation of gate/base circuits from power circuits. **(06 Marks)**

c. A transistor switch of Fig Q2 (c) 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. **(08 Marks)**

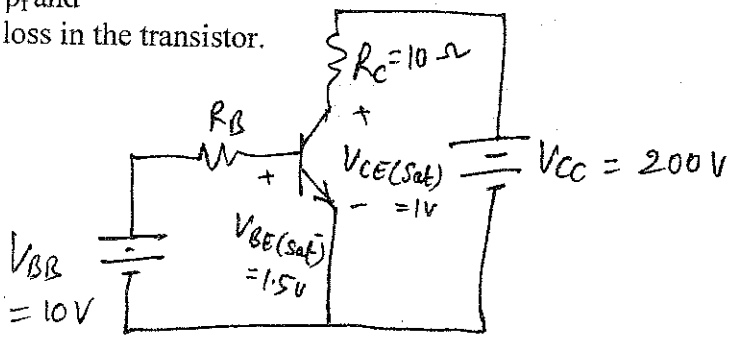

Fig Q2 (c)

3 a. Explain the principle of operation of an SCR using two transistor model. **(06 Marks)**

b. What is the need for protection of thyristors. Explain how thyristors are protected against high $\frac{di}{dt}$ and high $\frac{dv}{dt}$. **(07 Marks)**

c. A string of series connected thyristors is to with stand a dc voltage of 16 kV. The maximum leakage current and recovery charge differences of the thyristors are 10 mA and 100 μC respectively. The derating factor for steady-state and transient voltage sharings are 20%. For a maximum steady state voltage sharing of 1 kV. Determine

i) The steady state voltage sharing resistance R for each thyristor and

ii) The transient voltage capacitance C_1 for each thyristor. **(07 Marks)**

Contd... 2

4 a. What is forced commutation? Discuss the following forced commutation techniques.
   i) Self commutation.
   ii) Impulse commutation. **(14 Marks)**

b. Obtain proper values of the commutating components for the circuit shown in Fig. Q4 (b). The load current to be commutated is 5 A, turn off time is 50 μsec. Supply voltage is 100 V, SCR_2 holding current is 2 mA. Derive the equation used. **(06 Marks)**

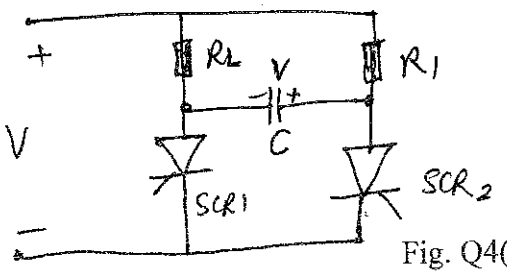

Fig. Q4(b)

5 a. With necessary waveforms, explain the operation of a 1φ full wave controller with inductive load. Derive expressions for rms output voltage and rms output current. **(10 Marks)**

b. Explain why short duration gate pulses are not suitable for bidirectional ac voltage controllers with inductive loads. **(03 Marks)**

c. A 1φ full wave ac voltage controller supplies a resistive load of R = 10 Ω from an input voltage Vs = 200 V, 60 Hz. The delay angles of the thyristors are equal, $\alpha_1 = \alpha_2 = \frac{\pi}{2}$. Determine
   i) The rms output voltage.
   ii) The input p.f and
   iii) Average current of thyristors
   iv) Rms current of thyristors. **(07 Marks)**

6 a. With the help of relevant waveforms, explain the working of a 1φ full converter assuming continuous current operation. Derive expressions for average and rms output voltages. **(10 Marks)**

b. With necessary waveforms explain the working of a 3φ half wave converter. Obtain expressions for average and rms output voltages. **(10 Marks)**

7 a. Explain the principle of operation of a step-up chopper. **(06 Marks)**

b. With the help of necessary mode equivalent circuits and waveforms, explain the operation of an impulse commutated chopper. **(14 Marks)**

8 a. What are inverters? Explain the working of an half bridge inverter with necessary waveforms. What is the function of the feed back diodes? **(10 Marks)**

b. Explain how the output voltage of a 1φ inverter is controlled using sinusoidal P.W.M technique. **(10 Marks)**

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EC42

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NEW SCHEME

Fourth Semester B.E. Degree Examination, July 2007
EC / TE / EE / IT / ML / BM
Power Electronics

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

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

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

b. What are the peripheral effects of power converter system? **(04 Marks)**

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

2 a. With the necessary waveforms explain the switching characteristics of a power transistor. **(07 Marks)**

b. Give the comparison between SCR, MOSFET and IGBT. **(06 Marks)**

c. With the necessary sketches, explain the switching characteristics of an IGBT. **(07 Marks)**

3 a. Sketch the static V-I characteristics of an SCR and then explain
i) Latching current.
ii) Holding current.
iii) Break over voltage. **(08 Marks)**

b. Explain the various methods of turn-on of an SCR and mention the advantages of gate triggering. **(08 Marks)**

c. The thyristor is gated with a pulse width of 40 μsec. The latching current of thyristor is 36 mA. For a load of 60 Ω and 2H, will the thyristor get turned ON? If not, how it can be overcome for the given load? Find its value. **(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 = 4 μH. The initial capacitor voltage is V_0 = 200 V. Determine the circuit turn OFF time for the load current I_m = 250 A. **(04 Marks)**

5 a. What are the advantages of freewheeling diode? Explain the principle of operation of a single phase HWR feeding an 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 for 10 kW rating is required. Thyristor of current rating 50 A are to be used. Find the rated voltage of thyristor using a safety factor of 2, if the rectifier is
i) Full wave using centre tapped transformer.
ii) Full wave bridge rectifier.
Assume RL load. **(04 Marks)**

Contd....2

6 a. Classify the choppers and explain the different types and chopper circuits. **(08 Marks)**

b. Obtain an expression for the output voltage for a step-up chopper. Explain how duty cycle is controlled. **(08 Marks)**

c. A dc chopper has an input voltage of 200 V and a load of 8 Ω resistance. The voltage drop across thyristor is 2 V and the chopper frequency is 800 Hz. The duty cycle $\alpha = 0.4$. Find

i) Average output voltage.
ii) Rms output voltage.
iii) Chopper efficiency. **(04 Marks)**

7 a. With necessary circuit and waveforms, explain the operation and fullwave a.c. voltage controller feeding an 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 half wave ac voltage controller has an input voltage of 150 V and a load resistance of 8 Ω. The firing angle of thyristor is 60° in each positive half cycle. Find

i) Average output voltage.
ii) RMS output voltage.
iii) Power output.
iv) Power input
v) Average input current over one cycle **(06 Marks)**

8 a. What do you mean by Inverters? Explain the operation of single phase full bridge inverter. Draw the load current waveforms for R, RL and RLC loads. **(08 Marks)**

b. With necessary circuit and waveforms, explain the operation of three phase bridge inverter with 180° mode of operation. **(08 Marks)**

c. Explain how harmonics can be reduced by transformer connections. **(04 Marks)**

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EC42

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

Time: 3 hrs. Max. Marks:100

Note :1. ***Answer any FIVE full questions.***

1 a. Explain the peripheral effects caused by power electronic converters. **(06 Marks)**

b. Give the characteristic features of the following devices:
i) MOSFET ii) Triac iii) GTO iv) RCT **(08 Marks)**

c. Latching current of a SCR, with a dc voltage source of 200 V, is 100 mA. Compute the minimum width of gate pulse current required to turn-on this SCR, in case the load consists of i) L = 0.2 H ii) R = 20 Ω in series with L = 0.2 H and iii) R = 20 Ω in series with L = 2.0 H. **(06 Marks)**

2 a. Give the construction, static characteristics and applications of IGBT. **(06 Marks)**

b. With circuit diagrams, discuss the methods for providing isolation of gate / base circuits from power circuit. **(08 Marks)**

c. The collector clamping circuit of figure Q2 (c) has V_{CC} = 100 V, R_C = 1.5 Ω, V_{d1} = 2.1 V, V_{d2} = 0.9 V, V_{BE} = 0.7 V, V_B = 15 V and R_B = 2.5 Ω and β = 16. Calculate i) the collector current without clamping, ii) the collector-emitter clamping voltage, V_{CE} and iii) the collector current with clamping. **(06 Marks)**

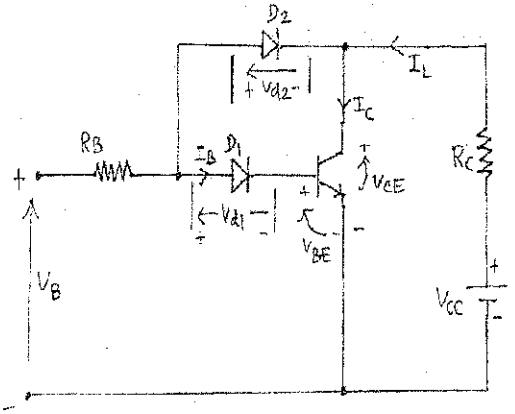

Fig. Q2 (c)

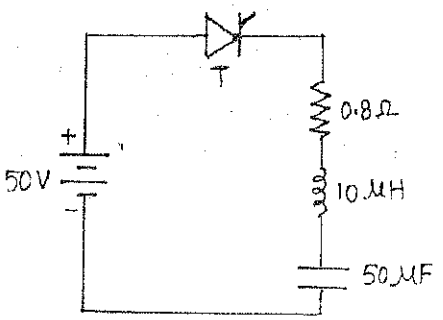

Fig. Q4 (c)

3 a. Using two-transistor model, explain the switching action of a thyristor and significance of gate control. Also derive an expression for the anode current. **(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. **(06 Marks)**

c. Twelve thyristors are used in a string to withstand a DC voltage of 16 KV. The maximum leakage current and recovery charge differences of the thyristors are 10 mA and 175 μC respectively. Each thyristor has equalizing components of R = 56 KΩ and C = 0.5 μF. Determine the derating factors for i) steady state and ii) transient state. **(06 Marks)**

4 a. Distinguish between:
i) Voltage commutation and current commutation.
ii) Load-side commutation and Line-side commutation. **(06 Marks)**

b. Explain with the help of a circuit diagram and relevant waveforms, the operation of an impulse commutated circuit with accelerated recharging. **(08 Marks)**

4 c. Commutation circuit for a SCR by resonating load is as shown in figure Q4 (c). Check whether the SCR is self-commutated. Calculate the time of conduction of SCR and the voltage of the capacitor at the time of commutation. **(06 Marks)**

5 a. Derive an expression for the rms value of the output voltage of a bi-directional AC voltage controller, employing on-off control. **(06 Marks)**

b. Explain the operation of a single-phase phase-control type of voltage controller with RL load. Give an illustration to show that for firing angle α less than load angle θ, output voltage of the AC voltage controller cannot be regulated. **(08 Marks)**

c. A single phase full-wave voltage controller has an input voltage of 230 V and a load having R = 4 Ω and L = 22 mH. The frequency is 50 Hz. The firing angles are 60° for both thyristors. Find i) Conduction angle of thyristors and ii) rms output voltage. **(06 Marks)**

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

b. With neat circuit and wave diagrams, explain the working of a line-commutated converter, which can function as a rectifier and also as an inverter. Derive an expression for its average output voltage. **(10 Marks)**

c. A single phase dual converter is operated from a 230 V, 50 Hz supply and the load resistance is R = 10 Ω. The circulating inductance is L_r = 40 mH. Delay angles are $\alpha_1 = 60°$ and $\alpha_2 = 120°$. Calculate the peak circulating current and the peak current of converter I. **(06 Marks)**

7 a. With the help of circuit and quadrantal diagrams, explain the working of a class-E chopper. Mention the devices that provide path for the current in each quadrant. **(10 Marks)**

b. A chopper is feeding an RL load as shown in figure Q7 (b). The chopper frequency is 1 kHz and duty cycle K = 0.5. Calculate

i) The minimum instantaneous load current. ii) The peak instantaneous load current.
iii) The average value of load current. iv) The rms load current.
v) The rms chopper input current. **(10 Marks)**

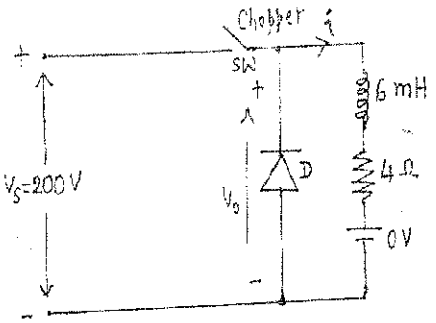

Fig. Q7 (b)

8 a. Explain the operation of a three-phase transistorized inverter in 180° conduction mode, with resistive star connected load. **(08 Marks)**

b. Write a note on voltage control of single phase inverters by sinusoidal pulse width modulation technique. **(05 Marks)**

c. A full-bridge inverter circuit has an input voltage of 200 V. The load is a series RLC circuit with R = 10 Ω, L = 20 mH and C = 100 μF. The inverter frequency is 50 Hz.

i) Express the instantaneous load current as fourier series. Consider upto 9^{th} harmonic only.
ii) Find the rms value of fundamental component of load current and
iii) Total harmonic distortion of the load current. **(07 Marks)**

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06EE45

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

Time: 3 hrs. Max. Marks:100

Note : ***Answer FIVE full questions, choosing at least two questions from each part.***

Part A

1 a. With neat circuit and waveforms of control signal and output voltage, explain the control characteristics of IGBT and SCR. **(08 Marks)**

b. Explain briefly the different types of thyristor power converters and mention two applications for each. **(09 Marks)**

c. What are the peripheral effects of power electronic circuits on load and source? **(03 Marks)**

2 a. Sketch and explain the switching characteristics of power BJT. The sketch should have the wave forms of i) V_{BE} ii) I_B iii) I_C. **(06 Marks)**

b. Sketch the structure of n – channel enhancement type MOSFET and explain its working principle. Also draw its transfer characteristics. **(08 Marks)**

c. The IGBT shown in the circuit of figure Q2 (c) has the following data:
$t_{ON} = 3\mu sec$, $t_{OFF} = 1.2\mu sec$, Duty cycle D = 0.7, $V_{CE(Sat)} = 2V$, $f_s = 1\,kHz$.
Determine i) Average load current, ii) Conduction power loss, iii) Switching power loss during turn-on and turn-off. **(06 Marks)**

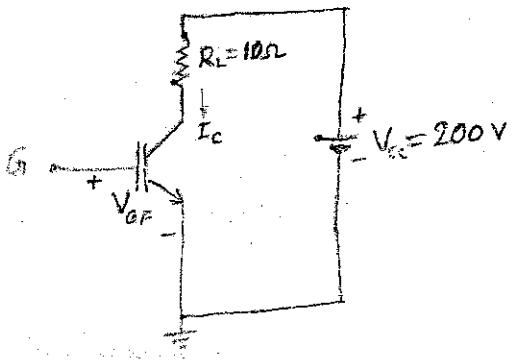

Fig. Q2 (c)

3 a. Using two transistor analogy, derive an expression for anode current of S.C.R. **(06 Marks)**

b. Calculate the required parameters for snubber circuit to provide $\frac{dv}{dt}$ protection to an SCR used in single phase bridge converter. The SCR has max $\frac{dv}{dt}$ capacity of 60V/μsec. The input line-to-line voltage has a peak value of 425 V and the source inductance is 0.2 mH. Damping factor = 0.65. **(04 Marks)**

c. Mention the different turn-on methods employed to switch-on SCR. Explain with waveforms, the resistance triggering circuit to turn-on SCR in the phase control circuit. **(10 Marks)**

4 a. What do you mean by commutation in thyristors? Differentiate between natural commutation and forced commutation. **(06 Marks)**

b. For class-C commutation circuit shown in figure Q4 (b) the D.C. source voltage is 120 V, and the current through R1 and R2 = 20 A. The turn off time of both the SCRs is 60μsec. Calculate the value of commutating capacitor 'C', for successful commutation. **(06 Marks)**

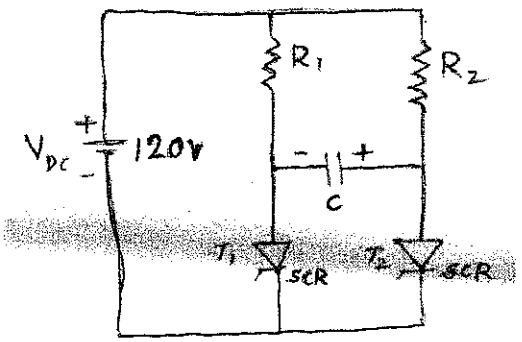

Fig. Q4 (b)

c. With neat circuit and waveforms explain the operation of complementary commutation. **(08 Marks)**

Part B

5 a. Derive an expression for RMS value of the output voltage for single-phase full wave (bi-directional) AC voltage controller with resistive load. **(10 Marks)**

b. An on-off controller, with an input of 230 V, 50 Hz is connected to a resistive load of 20Ω, the circuit is operating with the switch ON for 30 cycles and OFF for 30 cycles. Determine i) RMS output current ii) input power factor. **(10 Marks)**

6 a. With neat circuit and waveforms derive an expression for the RMS value of output voltage of single phase semi converter with RL load. (Assume discontinuous load current). **(06 Marks)**

b. A single phase half wave controlled rectifier is used to supply power to 10Ω load from 230 V, 50 Hz supply at a firing angle of 30°. Calculate i) Average output voltage ii) Effective output voltage iii) Average load current. **(06 Marks)**

c. With neat circuit and waveforms explain the working principle of 3 phase half wave controlled rectifier with 'R' load. **(08 Marks)**

7 a. A DC chopper shown in figure Q7 (a) has a resistive load of 10Ω and the input voltage, $V_s = 200V$. When the chopper switch is ON, its voltage drop is 2V and the chopping frequency is 1 kHz. If the duty cycle is 50%, determine i) Average output voltage ii) RMS output voltage, iii) The chopper frequency, iv) The effective input resistance of the chopper. **(08 Marks)**

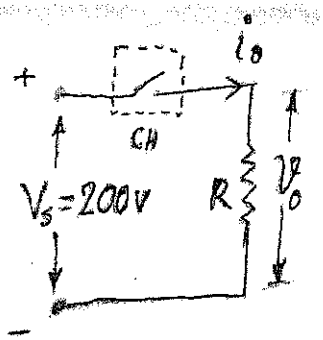

Fig. Q7 (a)

b. With neat circuit, explain the working principle of impulse commutated thyristor chopper. **(08 Marks)**

c. Explain briefly how choppers are classified. **(04 Marks)**

8 a. Obtain Fourier series for the output voltage waveform of full bridge inverter (single phase) with 'R' load. **(10 Marks)**

b. With the help of neat diagram and waveforms, explain the operation of 180° mode of 3 phase inverter with star connected 'R' load. **(10 Marks)**

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06EE45

Fourth Semester B.E. Degree Examination, June-July 2009
Power Electronics

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions choosing at least two questions from each part.***

PART – A

1 a. List out and explain the different types of Power Electronic converters. Show their output/input characteristics. **(08 Marks)**

b. What are the pheripheral effects of power converters. **(04 Marks)**

c. What is the necessity of base drive control in high power transistor? Explain proportional base and anti-saturation control. **(08 Marks)**

2 a. With necessary waveforms, explain the switching performance of power BJT. **(07 Marks)**

b. With relevant diagrams, discuss the methods for providing isolation of Gate/base drive control in power circuits and what are its limitations? **(07 Marks)**

c. In the circuit of Fig.Q2(c), the BJT has β in the range 10 to 25. If $V_{CC} = 230V$, $R_C = 12\Omega$, $V_{BB} = 15V$, $V_{CE(Sat)} = 1.2V$ and $V_{BE(Sat)} = 1.8V$, calculate :

i) the value of R_B required to move the transistor into saturation with an ODF of 6

ii) forced beta β_f ; iii) total power dissipation.

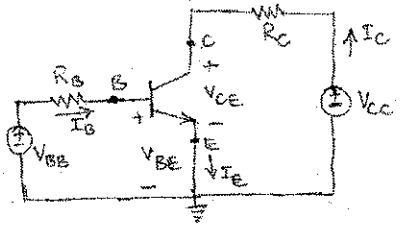

Fig.Q2(c)

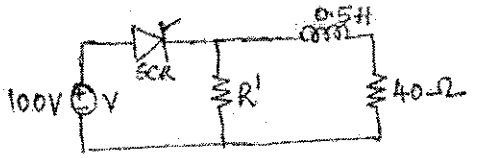

Fig.Q3(c) **(06 Marks)**

3 a. With neat sketch, explain the static V-I characteristics of an SCR? What are the significances of latching current, Holding current and Break over Voltage. **(08 Marks)**

b. With help of Two transistor Model of an SCR, derive the expression for anode current. There from explain the switching action and significance of Gate Control. **(08 Marks)**

c. The SCR in the circuit of Fig.Q3(c) has a latching current of 50 mA and if triggered by a Gate pulse width 50μ.sec. Show that with out resistance R^1 the thyristor will fail to remain ON when the gating pulse ends. Also find the maximum value of R^1 to ensure firing. The ON-State voltage drop of an SCR can be neglected. **(04 Marks)**

4 a. Define commutation? What are the necessity and conditions of commutation? Explain briefly types of commutation circuits. **(08 Marks)**

b. With necessary circuit and waveforms, explain complementary commutation scheme. Derive an expression for the same. **(08 Marks)**

c. Circuit of Fig.Q4(c) employing class-C commutation has $V_S = 200V$, $R_1 = 10\Omega$ and $R_2 = 100\Omega$. Determine : i) Peak value of current through thyristors T_1 ; ii) Value of capacitor C if each thyristor has turn-off time of 40 μ.sec. Take factor of safety as 2.

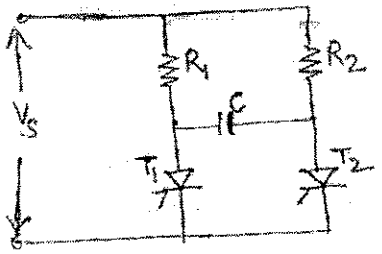

Fig.Q4(c) **(04 Marks)**

PART – B

5 a. What is an A C voltage regulator (controller)? With the help of waveforms, explain ON-OFF control and phase control. **(06 Marks)**

b. Explain the operation of a single phase bidirectional controller with resistive load. Obtain the equation for r. m. s. and output voltage. Show the waveforms. **(08 Marks)**

c. The single phase full wave ACVC in Fig.Q5(c), operates on a single phase supply voltage of 230V rms at 50 H_3. If the triac is triggered at a delay angle of α (Alpha) = 45^0 during both the half cycles of the input supply, calculate

i) rms value of the output voltage
ii) $I_{o(rms)}$ through the heater element
iii) Average value of the triac current
iv) rms value of triac current

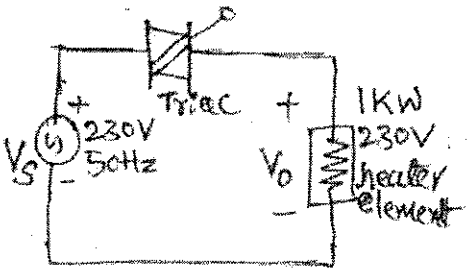

Fig.Q5(c) **(06 Marks)**

6 a. What is the use of freewheeling diode in converters? Explain the principle operation of single phase FWR feeding with RL load. Draw the relevant sketch and waveforms. **(06 Marks)**

b. With neat circuit and waveforms, explain the working of a line Commutated Converter, which works as rectifier and also as an Inverter. Derive an expression for its average output voltage. **(10 Marks)**

c. A single phase dual converter is supplying a load having R = 10Ω from an ac source of 230V, 50H_3. If the delay angle of the converters are $\alpha_1 = 60^0$ and $\alpha_2 = 120^0$ and the circulating current limiting inductance L_r = 50 mH, calculate the peak value of the circulating current and the peak current through converter – 1. **(04 Marks)**

7 a. What is chopper? Classify and explain the different types of choppers with each circuit diagrams. **(06 Marks)**

b. With the help of circuit and quadrantal diagrams, explain the working of a class-E chopper. Mention the devices that gives path for the current in each quadrant. **(08 Marks)**

c. In the chopper circuit of Fig.Q7(c), the average output voltage is 109V. The voltage drop across the chopper switch when it is ON i.e. V_S = 2V. If the load resistance R = 10Ω, f = 1.5KHz and duty ratio δ = 50%, calculate :

i) The dc Input voltage to the chopper.
ii) The rms output voltage
iii) The chopper efficiency
iv) Input resistance of chopper.

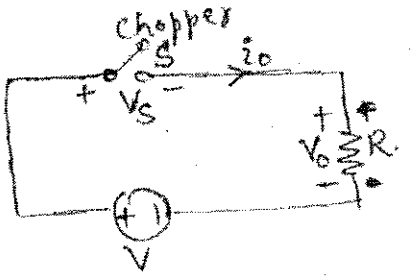

Fig.Q7(c) **(06 Marks)**

8 a. What do you mean by Inverters? Explain the operation of single phase full bridge inverter. Draw the load current waveforms for R, RL and RLC loads. **(06 Marks)**

b. Explain the operation of a three phase transistorized Inverter in180^0 conduction angle mode with Star-Connected Resistive load. **(08 Marks)**

c. Write a note on voltage Control of Single phase Inverter by Sinusoidal and multiple pulse width modulation techniques. Show their waveforms. **(06 Marks)**

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06EE45

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

Time: 3 hrs. Max. Marks:100

Note: 1. *Answer any FIVE full questions, selecting at least TWO questions from each part.*
2. *Missing data may be suitably assumed.*

Part – A

1 a. Give the circuit symbol, output characteristics and applications of various semiconductor devices. **(10 Marks)**

b. With the help of circuit and waveforms, explain the various types of power electronic converter circuits. **(10 Marks)**

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

b. With the help of necessary waveforms, explain the switching characteristics of an IGBT. **(06 Marks)**

c. What is the necessity of base drive control? Explain the various methods of base drive control used for BJTs. **(08 Marks)**

3 a. Explain the two transistor analogy of a thyristor. **(06 Marks)**

b. Mention and explain the various methods of turn ON used for thyristors. **(08 Marks)**

c. The thyristor is gated with a pulse width of 40 μsec. The latching current of thyristor is 36 mA. For a load of 60 Ω and 2 H, will the thyristor get turned ON? If the answer is negative, how this problem can be overcome for the given load? Find the value of remedial parameter. Given $V_s = 300V$. **(06 Marks)**

4 a. What do you mean by commutation? Explain the method of self commutation with necessary circuit and waveforms. **(07 Marks)**

b. With necessary circuit and waveforms, explain the complementary commutation method. **(07 Marks)**

c. In the resonant pulse commutation circuit, the capacitance C = 30 μF and inductance L = 4 μH. The initial capacitor voltage is $V_0 = 200$ V. Determine the circuit turn-off time t_{off} if the load I_m is 50 A. **(06 Marks)**

Part – B

5 a. With the help of circuit diagram and waveforms, explain the operation 1Q bidirectional voltage controller with R-L load. **(07 Marks)**

b. Explain the principle of ON-OFF control. Obtain an expression for rms voltage, rms current and p.f. for full wave AC voltage controller. **(07 Marks)**

c. A single phase half wave ac voltage controller has a resistive load of R = 10 Ω and the input voltage Vs = 120 V, f = 60 Hz, $\alpha = \frac{\pi}{2}$. Determine i) rms value of output voltage, ii) Input power factor iii) Average input current. **(06 Marks)**

6 a. For a single phase semi-converter with R-L load operating in continuous mode, i) Draw the circuit diagram, input and output waveforms ii) Derive an expression for average and rms output voltages. **(10 Marks)**

b. With the circuit diagram, explain the operation of three phase full converter for constant load current. If the input to this circuit is 3 phase, 50 Hz supply, determine the firing angle α for the SCRS to obtain an output average dc voltage of 50% of the maximum. If this output voltage is 270 V, calculate ac supply line-line rms voltage. **(10 Marks)**

7 a. What is chopper? Explain the operation of various types of chopper. **(08 Marks)**

b. With the help of circuit and waveforms, explain the operation of step up chopper. **(06 Marks)**

c. In the step down chopper $V_s = 230$ V, load resistance is 10 Ω. Take a voltage drop of 2 V across chopper when it is ON. For a duty cycle of 0.4, calculate i) Average and rms values of output voltage. ii) Chopper efficiency. **(06 Marks)**

8 a. Explain the concept of sinusoidal modulation technique of voltage control in an inverter. **(06 Marks)**

b. What is the effect of harmonics? Explain harmonic reduction by transformer connection method. **(08 Marks)**

c. For the inverter circuit shown in figure,

i) Sketch to scale the waveforms of V_0, i_0, i_{Q1}, i_{Q2}, i_1 and i_2.

ii) Power delivered to load.

iii) State whether this circuit will require forced commutation. **(06 Marks)**

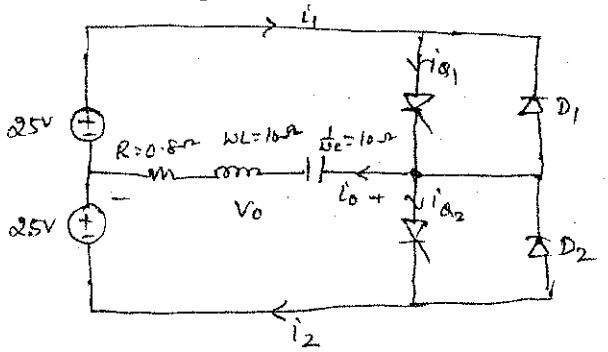

Fig. Q8 (c)

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