AMIETE – ET (OLD SCHEME)

Code: AE26

DECEMBER 2009

Time: 3 Hours

Subject: POWER ELECTRONICS

Max. Marks: 100

NOTE: There are 9 Questions in all.

- **Question 1 is compulsory and carries 20 marks. Answer to Q. 1must be written in the space provided for it in the answer book supplied and nowhere else.**
- **Out of the remaining EIGHT Questions answer any FIVE Questions. Each question carries 16 marks.**
- **Any required data not explicitly given, may be suitably assumed and stated.**

Q.1   Choose the correct or the best alternative in the following: (2x10)

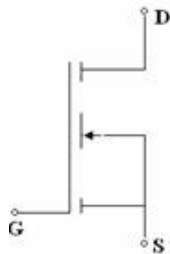a.   In an SCR circuit, the angle of conduction can be changed by changing

   (A) anode voltage   **(B)** anode current
   (C) forward current rating   **(D)** gate current

b.   Circuit symbol for IGBT is
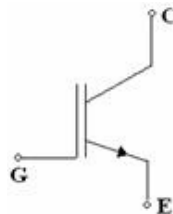

   (A)   **(B)**

   (C)   **(D)**

c.   If the chopper switching frequency is 200 Hz and T_{ON} time is 3 ms, the duty cycle is

   (A) 0.4   **(B)** 0.8
   (C) 0.6   **(D)** 0.75

d.   In a three phase half-wave rectifier, the peak inverse voltage equals.

(A) $\left(\sqrt{6}\right)E$ (B) $\left(\sqrt{3}\right)E$

(C) (2)E   (D) $\left(\sqrt{\frac{3}{2}}\right)E$

E = RMS voltage of secondary.

e. A freewheeling diode is sometimes connected in an inductive load circuit. Its purpose in a half wave rectifier circuit is

    (A) to conduct during the negative half of supply.
    (B) to give better filtering and reduce ripple.
    (C) to conduct so as to reduce the angle of conduction to π.
    (D) to improve transformer utilisation.

f. A UJT is used for triggering an SCR has the supply voltage $V_{BB} = 25V$. The intrinsic standoff ratio = 0.75. The UJT will conduct when the biased voltage V_E is

    (A) 25 V   (B) $\geq 18.75A$
    (C) 33.3V   (D) $\geq 19.35V$

g. When a line commutated converter operates in the inverter mode, it

    (A) draw both reactive and real power from the ac supply.
    (B) delivers both real and reactive power to the ac supply.
    (C) delivers real power to the ac supply.
    (D) draws reactive power from ac supply.

h. When a series LC circuit is connected to a dc supply of V volts through a thyristor, then the peak current through thyristor is

    (A) $V \cdot \sqrt{LC}$ (B) $V / \sqrt{LC}$

    (C) $V \cdot \sqrt{\frac{C}{L}}$ (D) $V \cdot \sqrt{\frac{L}{C}}$

i. In a current source inverter, if frequency of the output voltage is f Hz, then frequency of the voltage input to CSI is

    (A) f   (B) 2f
    (C) $f/2$ (D) 3f

j. A 3-phase to 3-phase cyclo converter requires

    (A) 18 SCR's for 3-pulse device   (B) 18 SCR's for 6-pulse device
    (C) 36 SCR's for 3-pulse device   (D) 36 SCR's for 6-pulse device

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Answer any FIVE Questions out of EIGHT Questions.
Each question carries 16 marks.

Q.2   a. Discuss the construction and static V-I characteristics of an SCR. Show latching current and holding current on its V-I characteristics.   **(8)**

     b. Determine the values of $\frac{di}{dt}$ inductance and snubber circuit parameters R_s and C_s for the circuit shown in Fig.1. The supply voltage is 300 V dc, load resistance $R_L = 10\Omega$ and repetitive peak current is $I_P = 80A$. The

specified limit for $\dfrac{di}{dt}$ and $\dfrac{dv}{dt}$ for the SCR are 25 $A/\mu sec$ and 250 $A/\mu sec$ respectively. Take damping factor ξ to be about 0.72 for critical coordination   3)
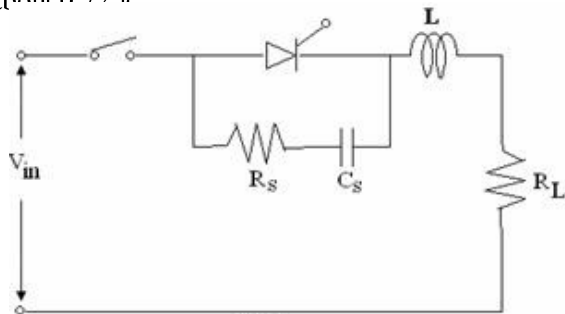

Fig.1

Q.3   a.   Draw the waveforms for the average load voltage and load current for an RL load fed from a single phase supply through a thyristor. Also derive the expression for load current.   **(8)**

b.   Fig.2 shows a battery charging circuit using SCR's. Derive the expression and find the value for average current flowing through the battery if the voltage from neutral to any line is 230V (rms) and firing angle for thyristor is $30°$.
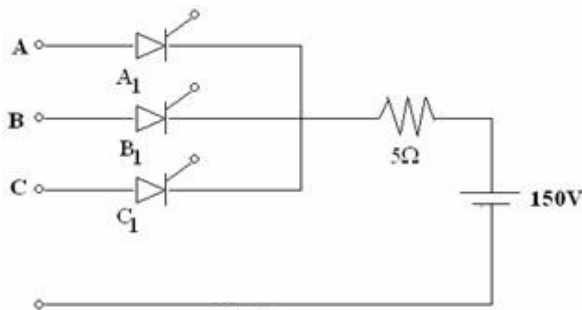
(8)

Fig.2

Q.4   a.   A step down dc chopper with an input voltage of 220 V has a resistive load of R=15 Ω, a chopping frequency of 1 KHz and a duty cycle of 50%. If the voltage drop at chopper, when the chopper switch remains on is 4 V determine
(i)   The average output voltage and rms voltage
(ii) The effective input resistance R_i of the chopper and chopper efficiency.   **(8)**

b.   What is a buck regulator? Write its advantage and disadvantages.   **(8)**

Q.5   a.   Explain the need of commutation in thyristor circuits. What are the different methods of commutation schemes?   **(8)**

b.   Determine the available turn off time for the impulse commutated thyristor circuit as shown in Fig.3, if $V_{in} = 250V, R_L = 15\Omega$, $C = 6\mu F$ and $V_o = V_{in}$.   **(8)**
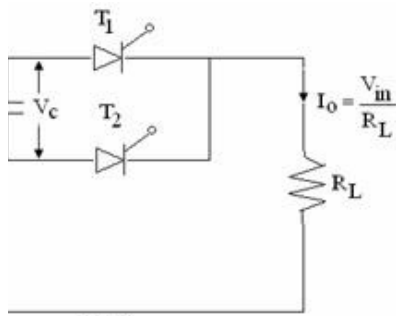
Fig.3

Q.6 a. A single phase voltage controller has input voltage 220V, 50 Hz and a load of $R_L = 12\Omega$. For 6 cycles on and 4 cycles off determine
(i) input power factor and rms output voltage.
(ii) average and rms thyristor current. **(8)**

b. Discuss the principle of ON-OFF control and phase control for power transfer. **(8)**

Q.7 a. What is a cyclo converter? List some of its industrial applications. **(8)**

b. Show that the fundamental rms value of per phase output voltage of low frequency for an m-phase half wave cyclo converter is given by

$$V_{OR} = V_{ph}\left(\frac{m}{\pi}\right) \sin\left(\pi/m\right)$$

where V_{ph}=rms value of supply voltage and firing angle α is given as $0°$.
(8)

Q.8 a. A resistive load of 5Ω is fed from a dc input voltage $V_s = 60V$ through a single phase half bridge and full bridge (one at a time) inverter. Compare the output rms voltage, rms output current at fundamental frequency, the output power and the peak reverse blocking voltage for both the cases. **(8)**

b. A three phase bridge inverter delivers power to a resistive load from a 300 V dc source. For a star-connected load of 5Ω per phase, determine
(a) rms value of load-current. (ii) load power,
for both (i) $180°$ mode and (ii) $120°$ mode. **(8)**

Q.9 a. The speed of a 15 HP, 220 V, 1000 rpm dc series motor is controlled using a single-phase half controlled bridge converter. The combined armature and field resistance is 0.2 ohm. Assume continuous and ripple free motor current and speed of 1000 rpm and K = 0.03 Nm/amp^2. Determine
(i) motor current and (ii) motor torque
For, a firing angle $\alpha = 30°$, AC voltage = 250 V. **(8)**

b. Discuss dc circuit model of chopper controlled rotor circuit resistance of an induction motor.
(8)