CS/B.Tech/EEE(NEW)/SEM-6/EEE-603/2013

2013

POWER ELECTRONICS

Time Allotted : 3 Hours   *Full Marks* : 70

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words

as far as practicable.

GROUP – A

### (Multiple Choice Type Questions)

1.   Choose the correct alternatives for the following : $10 \times 1 = 10$

   i)   An IGBT has three terminals called

      a)   collector, emitter and base

      b)   drain, source and base

      c)   drain, source and gate

      d)   collector, emitter and gate.

ii) In an SCR

    a) latching current I_L is associated with turn-off process and holding current I_H with turn-on process

    b) both I_L and I_H are associated with turn-off process

    c) I_H is associated with turn-off process and I_L with turn-on process

    d) both I_L and I_H are associated with turn-on process.

iii) For an SCR, (dv/dt) protection is achieved through the use of

    a) RL in series with SCR   b) RC across SCR

    c) L in series with SCR   d) RC in series with SCR.

iv) In a CSI, if frequency of output voltage is f Hz, then frequency of voltage input to CSI is

    a) f b) $2f$

    c) $f/2$ d) $3f$.
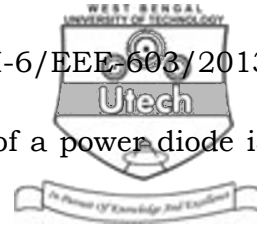
v) The reverse recovery characteristics of a power diode is due to

    a) stored charge in depletion layer

    b) stored charge in semiconductor layers

    c) stored charge in both depletion and semiconductor layers

    d) none of these.

vi) HVDC transmission is preferred to EHV-AC transmission because

    a) HVDC terminal equipment are expensive

    b) VAr compensation is not required for HVDC systems

    c) system stability can be improved

    d) harmonic problem is avoided.

vii) *A* class *D* chopper

    a) can operate in first quadrant only

    b) can operate in second quadrant only

    c) can operate in first and forth quadrant

    d) can operate in all the quadrant.

viii) In a control rectifier a freewheeling diode necessary if the load is

    a) inductive   b) resistive

    c) capacitive   d) any of these.

ix) In a single phase full wave controlled rectifier using centre tap transformer, the voltage across each half secondary in $V_m \sin \omega t$. The peak inverse voltage is

    a) $2V_m$ b) V_m

    c) $0 \cdot 5 V_m$ d) $0 \cdot 25 V_m$.

x) Each thyristor of a 3-phase full converter conducts for

    a)   30°   b)   60°

    c)   120°   d)   240°.

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following.   3 × 5 = 15

2. Draw and explain the switching characteristics of IGBT.

3. Explain with necessary waveforms, the principle of operation of an RC triggering circuit for triggering of SCR.

4. Draw and explain dynamic or switching characteristics of an SCR.

5. An SCR is used to feed a load resistance 8 Ω from a 230 V 1-φ *a.c.* supply. The ratings of SCR are : Repetitive peak current = 200 A, (di/dt)$_{max}$ = 40 A/µ-sec and (dv/dt)$_{max}$ = 150 V/µ-sec. Design a snubber circuit for protection of the SCR.

6. Explain the principle of operation of step down chopper with *R* load. Deduce the expression of *O/P* voltage of such chopper.
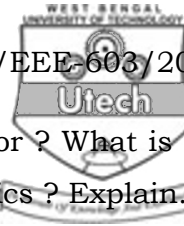
7. a) Draw the *V-I* characteristics of a thyristor ? What is the effect of gate current on the characteristics ? Explain.

   b) Discuss dv/dt triggering of a thyristor.   4 + 1

GROUP – C
(Long Answer Type Questions)
Answer any *three* of the following.   3 × 15 = 45

8. a) Explain the operation of a 1-φ half-controlled bridge converter connected to *R-L* load. Show the waveforms of the output voltage, SCR current & source current for a firing angle & considering ripple free output current.

   b) Derive the expression for average & RMS value of output voltage for the converter mentioned in (a).

   c) A battery is charged by a fully controlled 1-φ converter as shown in the figure below. The input supply is 30 V at 50 Hz. The load consists of a 24 V battery and a resistance of 50 Ω connected in series to limit the current. Calculate the minimum possible firing angle. Also calculate the value of average output voltage.

6 + 4 + 5

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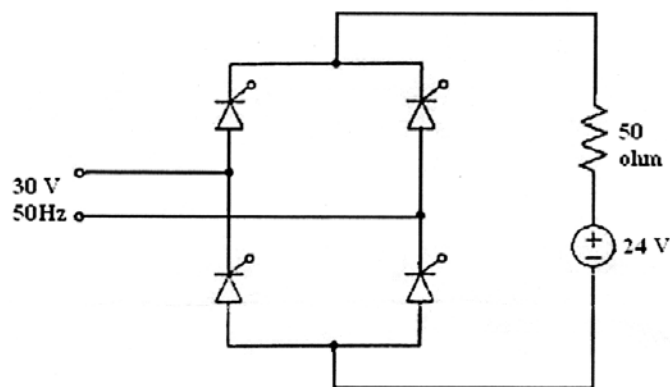
9. a) What is a cycloconverter ? What benefits does it offer in comparison to inverter ?

   b) With the help of schematic diagram and relevant waveforms, explain the operation of 3-φ to 1-φ cycloconverter.

   c) What do you mean by blocked group operation and circulating current mode operation of a cycloconverter ?

   d) Mention some applications of cycloconverter.

   $$3 + 6 + 3 + 3$$

10. a) With associated waveforms explain the rectification mode and inversion mode operation of a single-phase full converter with bridge circuit.

    b) Derive the expression for average load voltage, R.M.S. load voltage and average load current.

    c) How freewheeling diode improves the power factor of the system ? Explain. $$7 + 6 + 2$$

11. a) With the help of neat circuit diagram and waveforms explain briefly the operation of 3-φ bridge inverter with resistive load in 180° conduction mode.

    b) A 3-φ is fed by a 400 V battery. The load is star connected and has a resistance of 10 ohms per phase. Find *rms* load current, power output, peak current of thyristor and average and *rms* current of thyristor. Assume 120° mode of operation. $$8 + 7$$

12. a) Draw the circuit of a two-quadrant chopper and explain its working principle.

   b) A step-down *d.c.* chopper has a resistive load of $R = 15\ \Omega$ and input voltage $E_{dc} = 200$ V. When the chopper remains ON, its voltage drop is 2·5 V. The chopper frequency is 1 kHz. If the duty cycle is 50%, determine the following :

   i) average output voltage

   ii) *rms* output voltage

   iii) chopper efficiency.

   c) Explain resonant pulse inverter. 5 + 5 + 5

13. Write short notes on any *three* of the following : 3 × 5

   a) Complementary commutation of SCR

   b) Different turn-on methods of SCR

   c) Dual Converter

   d) HVDC transmission

   e) SMPS.

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