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Paper Code : EE-603

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 any *ten* of the following : $10 \times 1 = 10$

   i) The advantage of an 180° conduction three phase inverter over an 120° conduction three phase inverter is

      a) it needs less number of switches

      b) there is no paralleling of switches

      c) devices in series are not simultaneously switches

      d) load terminals are not left open during switches.

ii) A freewheeling diode across inductive load of a phase-controlled converter will provide

a) quick turn-on of SCR

b) slow turn-off of SCR

c) reduced utilization factor of transformer

d) improved power factor.

iii) The switching frequency of a MOSFET will be reduced with

a) an increase in the output impedance of the device

b) an increase in the discharge rate of the input capacitance

c) an increase in the source resistance

d) a decrease in the discharge rate of the input capacitance.

iv) For a two-quadrant type-A chopper, regenerative braking is

a) possible at low speeds

b) possible at high speeds

c) possible at both high and low speeds

d) not possible at all.

v) RC snubber circuit is used to limit rate of

a) rise of current in SCR

b) rise of voltage across SCR

c) rise of capacitance of depletion layer

d) all of these.

vi) RC snubber circuit is used to limit rate of

a) rise of current in SCR

b) rise of voltage across SCR

c) conduction period

d) all of these.

vii) Cyclo-converter is a

a) AC to AC converter

b) AC to DC converter

c) DC to AC converter

d) DC to DC converter.

viii) The range of firing angle in case of RC firing circuit will be

a) $0° - 90°$ b) $90° - 180°$

c) $0° - 180°$ d) $45° - 90°$

ix) The output voltage waveform of a three phase square wave inverter contains

a) only odd harmonics

b) both odd and even harmonics

c) only even harmonics

d) only triplen harmonics.

x) A 1-phase full bridge VSI has inductor L as load. For a constant voltage source, the current through the inductor is

a) square wave b) triangular wave

c) sine wave d) pulse wave.

xi) The cyclo-converters (CCs) require

a) Natural commutation in both step-up and step-down CCs

b) Forced commutation in both step-up and step-down CCs

c) Forced commutation in step-down CCs

d) Forced commutation in step-up CCs.

xii) Compared BJT, MOSFET has

a) low switching frequency and low conduction loss

b) high switching frequency and low conduction loss

c) high switching frequency and high conduction loss

d) low switching frequency and high conduction loss.

GROUP – B

(Short Answer Type Questions)

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

2. Describe the effect of source inductance on the output voltage of a single phase full controlled bridge converter.

3. What is snubber circuit ? Why snubber circuit are used in thyristor circuit ? 3 + 2

4. Briefly describe the working of class *B* chopper with diagram.

5. A thyristor is used to feed a load resistance 8 ohms from a 230 V single phase supply. The ratings of thyristors are repetitive peak current = 200 A, (di/dt) max = 40 A/μs and (dv/dt) max = 150 V/μs. Design a snubber circuit for protection of thyristor.

6. What is cyclo-converter ? Explain the operation of a single phase step-up cyclo-converter.

GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following. 3 × 15 = 45

7. a) Describe the different modes of operation of thyristor using static V-I characteristics. What is the effect of gate current on this characteristic ?

b) With two transistor analogy explain how a small gate current can turn-on a SCR.

c) What is the necessity of connecting SCRs in series ? What are the problem associated with series connection of SCRs ? How are they eliminated ? 5 + 5 + 5

8. a) What is the difference between semi converter and full converter ?

b) A single-phase fully controlled bridge converter is supplied from 230 V, 50 Hz *ac* supply and fed to a load which consists of R = 20 Ω and large inductance, so that load current is constant and ripple free. If the firing angle is 30° find the

i) average and rms of load voltage

ii) average and rms of thyristor current

iii) average and rms of source current and

iv) input power factor.

c) A three-phase half wave-controlled rectifier connected across *R* load. Draw the output voltage and phase current waveforms. And also find out the expression of average output voltage at a firing angle of $\propto \left[where, 0 < \propto < \frac{\pi}{6}\right]$. 2 + 8 + 5

9. a) Derive the expression for ripple of inductor current for *dc* to *dc* buck converter. And also find out the value of duty cycle at which the ripple will be maximum.

b) Draw and explain a DC-DC boost converter. Derive an expression for average output voltage.

c) A step-down chopper has a resistive load of $R = 10\ \Omega$ and input voltage of 120 V. when the chopper is turned on, its voltage drop is 2 V. The chopper frequency is 1 KHz. If the duty cycle is 40% determine

i) Average output voltage

ii) RMS output voltage

iii) Efficiency of chopper. 4 + 5 + 6

10. a) State the comparison between voltage source inverter (VSI) and current source inverter *(CSI)*.

b) Draw the appropriate circuit diagram of three-phase bridge inverter connected to star connected resistive load and explain the operation with the help of phase voltage, line voltage and gate pulse waveforms for 120° conduction mode.

c) A three-phase inverter is supplied from a 580 V source. For a star connected resistive load of 20 Ω per phase, for 120° conduction. Determine the

i) rms value of phase voltage

ii) rms value of thyristor current. 2 + 9 + 4

[Turn over

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

a) Turn on methods of thyristor

b) Complementary commutation

c) Effect of source inductance for 2-pulse converter

d) Sinusoidal PWM

e) Schottkey barrier diode

f) Two-Quadrant chopper.