Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/B.Tech (EE-NEW)/SEM-5/EE-504/2010-11

2010-11
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) In an SCR holding current is

      a) equal to latching current

      b) less than IL

      c) more than IL

      d) not related to IL.

   ii) 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.

iii) Cycloconverter is a

a) AC to AC converter b) AC to DC converter

c) DC to AC converter d) DC to DC converter.

iv) The advantage of a 180° conduction three phase inverter over a 120° conduction three phase inverter is

a) it needs less number of switches

b) there is no parallelling of switches

c) devices in series are not simultaneously switched

d) load terminals are not left open during switching.

v) For continuous conduction each thyristor pair of a two pulse full converter should conduct for

a) π b) $\pi-\alpha$

c) α d) $\pi + \alpha$.

vi) di/dt protection for an SCR is achieved by

a) R in series with SCR

b) L in series with SCR

c) R across SCR

d) none of these.

vii) The maximum firing angle that can be obtained by a pure resistive trigger circuit used in phase control circuit is

a) 45° b) 90°

c) 135° d) 180°.

viii) Switched Mode Power Supply (SMPS) is preferred over continuous types because SMPS

a) is suitable for both AC and DC

b) is suitable for low power circuits

c) is suitable for high power circuits

d) provides low power loss.

ix) Which of the following devices does not have negative resistance characteristics ?

a) UJT b) SCR

c) FET d) Tunnel diode.

x) Each diode of a 3-phase half-wave diode rectifier conducts for

a) 60° b) 120°

c) 180° d) 90°

xi) Complementary commutation is

a) Class *C* chopper b) Class *D* chopper

c) Class *B* chopper d) Class *E* chopper.

xii) Chopper control of DC motor provides variation in

a) input voltage b) frequency

c) current d) all of these.

GROUP – B

(Short Answer Type Questions)

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

2. Name the performance indices of a rectifier. Why are freewheeling diodes used in rectifier circuit ?

3. What is commutation ? Where are forced commutation circuits are implemented ? Explain self-commutation method for SCR. 1 + 1 + 3

4. Draw the R-C firing circuit for SCR and explain with proper waveforms. Why are short pulses preferred over long pulse signals for thyristor triggering through isolation transformer ? 3 + 2

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, $(di/dt)_{max}$ = 40A/μs and $(dv/dt)_{max}$ = 150V/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. 1 + 4

GROUP – C

(Long Answer Type Questions)

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

7. a) Explain the operation of dual converter (circulating and non-circulating current mode). 10

   b) State the advantages and disadvantages of this scheme. 5

8. a) Explain the operation of fully controlled bridge circuit with R-L load (rectifying and inverting mode). Draw the waveform. 7

   b) A highly inductive *d.c.* load requires 12 A at 150 V from a 230 V single phase *a.c.* supply. Give the design details for the requirement using

      i) M-2 connection

      ii) B-2 connection,

      for firing angle 30 degree. 8

9. a) Derive the expressions of average output voltage and load current for a 3φ full converter. Draw associated waveforms. 8

b) A two pulse single phase bridge converter is connected to RLE load.

Source voltage is 230 V, 50 Hz. Average load current of 10 amps is continuous over the working range. For $R = 0{\cdot}4\ \Omega$ and $L = 2$ mH compute

i) firing angle delay for $E = 120$ V.

ii) firing angle delay for $E = -120$ V.

Indicate which source is delivering power to load in parts (i) and (ii). 7

10. a) Draw the circuit of a two quadrant chopper & explain its working. 5

b) A step down *d.c.* chopper has a resistive load of $R = 15$ ohm and input voltage Edc = 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

i) average output voltage

ii) RMS output voltage

iii) chopper efficiency. 5

c) Derive an expression for output voltage in terms of duty cycle for a step-up and step-down chopper. 5

11. a) How is the working of a full bridge single phase inverter different from that of half bridge circuit ? Explain with the help of diagrams. 4

b) A single phase half bridge inverter has a resistive load of 10 ohm and centre tap d.c. input voltage of 96 volts. Compute

i) RMS value of output voltage

ii) fundamental component of output voltage waveform

iii) first five harmonics of the output voltage

iv) fundamental power consumed. 4

c) Describe with the help of necessary voltage waveforms and circuit diagram the operation of a three phase voltage source inverter with 180 degree conduction. 4

d) Explain how zero current switching and zero voltage switching can be achieved in a series resonant converter. 3