Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/B.Tech(EE)/SEM-5/EE-504/2009-10

2009

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) Turn-off time of an SCR affects its

   a) operating voltage b) operating frequency

   c) overload capacity d) thermal behaviour.

   ii) A triac is semi-conductor device acting

   a) as a diode in the forward direction and SCR in the reverse direction

   b) as an SCR in both the directions

   c) as diode in both the directions

   d) as an SCR in one direction and diode in the other direction.

iii) A six pulse bridge converter feeds a pure resistive load. The control of the converter can be varied in the range

a) $0° \leq \alpha \leq 180°$ b) $0° \leq \alpha \leq 120°$

c) $0° \leq \alpha \leq 150°$ d) $30° \leq \alpha \leq 150°$.

iv) The ripple content of load current of a converter feeding RL load is decided by

a) load resistance alone

b) load inductance alone

c) both load resistance and load inductance

d) neither resistance and nor inductance.

v) A cycloconverter is effectively a

a) combination of a rectifier and an inverter connected antiparallel

b) combination of two rectifiers connected antiparallel

c) combination of two inverters connected antiparallel

d) combination of two converters connected antiparallel.

vi) For a two quadrant chopper designed for operation in I & IV quadrants, the output voltage

a) varies from + V_d to – V_d

b) varies from 0 to + V_d

c) varies from 0 to – V_d

d) varies from 0 to 0·5 V_d .

vii) In voltage source inverter

a) input voltage is maintained constant

b) input current is maintained constant

c) the amplitude of the output voltage depends on the load

d) the commutation circuits for SCR in CSI are comparatively complex than in VSI.

viii) The average value of voltage of a single phase *ac* voltage controller is given by

a) $\frac{\sqrt{2V}}{\pi}$ (1 + cos α) b) $\frac{\sqrt{2V}}{2\pi}$ (1 + cos α)

c) $\frac{\sqrt{2V}}{\pi}$ cos α d) $\frac{V}{\pi}$ cos α.

ix) A current source inverter is normally employed

a) if the source inductance is small

b) if the source inductance is large

c) on any source irrespective of its impedance

d) if the load is pure inductive load.

x) In resonant pulse commutation

a) the load current must be greater than peak value of peak resonant current

b) the load current must be equal to the peak value of resonant current

c) the peak value of resonant current must be greater than the load current

d) is always possible whatever be the value of resonant peak current compared to load current.

xi) A BJT operates as a switch

a) under small signal conditions

b) with no signal condition

c) in the active region of transfer characteristics

d) under large signal condition.

GROUP – B

(Short Answer Type Questions)

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

2. Why does an SCR not conduct when positive voltage is applied to it ? Explain how a gate pulse can make it conducting.

3. What is the necessity of connecting SCRs in series ? What are the problems associated with series connection of SCRs ? How are they eliminated ?

4. Draw and explain circuit diagram for the synchronized UJT triggering. Also draw the associated voltage waveforms.

5. A single phase converter feeds an R-L load having a resistance of 10 Ω in series with an inductance of 20 mH. The converter operates such that the *dc* voltage across the load is 250 V. The SCR used in the converter has holding current of 300 mA and a delay time of 5 μs. Determine the pulse width of gate current.

6. Briefly explain the V-I characteristics of an IGBT.

GROUP – C

(Long Answer Type Questions)

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

7. a) Explain with relevant circuit diagram and waveforms how rectification and inversion are possible in phase controlled converters with SCRs.

   b) A three phase fully controlled SCR bridge converter supplies a *dc* voltage source of 400 V having an internal resistance of 1·8 Ω. Assume highly inductive load with constant load current of 20 A. The supply RMS load voltage per phase is 230 V and source inductance in each phase is 0·005 H. Compute the following by ignoring the source resistance :

      i) Firing angle α for an output voltage of 436 V.

      ii) Overlap angle. 8 + 7

8. a) Explain the principle of operation of an inverter.

   b) Why are feedback diodes used in antiparallel with SCRs in inverters ?

   c) Compare 180° and 120° conduction modes of 3 phase bridge inverter.

   d) What is a PWM inverter ? What are its advantages ?

   4 + 2 + 5 + 4

9. a) With the help of circuit diagram, explain the working of class *D* chopper.

   b) A *dc* battery is charged from a constant *dc* source of 220 V through a chopper. The *dc* battery is to be charged from its internal *emf* of 90 V to 122 V. The battery has internal resistance of 1 Ω. For a constant charging current of 10 A, calculate the range of duty cycle.

   c) With the help of block diagram explain the basic principle of operation of SMPS. 5 + 5 + 5

10. a) Discuss why a three phase to single phase cycloconverter requires positive and negative group phase controlled converters. Under what conditions, does the group work as inverters or rectifiers ? How should the firing angles of the two converters be controlled ?

    b) For a single phase *ac* voltage regulator feeding a resistive load, draw the waveforms of source voltage, gating signals, output voltage, source and output currents and voltage across SCRs. Describe its working with reference to the waveforms drawn. 8 + 7

11. a) Draw the circuit diagram and explain the operation of slip power recovery system using solid state Scherbium system.

b) A 220 V, 1500 rpm, 12 A separately excited motor is controlled by a 1-phase fully controlled converter with an *ac* source voltage of 230 V, 50 Hz. Assume that sufficient inductance is present in the armature circuit to make the motor current continuous and ripple free for any torque greater than 25% of rated torque,
R_a = 2·5 Ω.

i) What should be the value of the firing angle to get the rated torque at 1000 rpm ?

ii) Determine the firing angle for the rated braking torque at 1500 rpm. 7 + 8