Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/B.Tech (EIE-NEW)/SEM-7/EE-701(EI)/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) PIV of full wave bridge rectifier is

   a) $\sqrt{2}\,V_m$ b) $2\,V_m$

   c) $V_m/\sqrt{2}$ d) none of these.

   ii) Reverse recovery current in a diode depends upon

   a) forward field current

   b) temperature

   c) storage current

   d) PIV.

iii) For an SCR, $\frac{dv}{dt}$ protection is achieved through the use of

a) RL in series with SCR

b) RC across SCR

c) L in series with SCR

d) L across SCR.

iv) Forced commutation is generally employed in

a) controlled rectifier b) cycloconverter

c) chopper d) none of these.

v) In a single phase full converter, the number of SCR conducting during overlap is

a) 1 b) 4

c) 3 d) 2.

vi) When a power BJT is compared to power MOSFET

a) BJT has lower switching losses but higher conduction losses

b) BJT has higher switching losses but lower conduction losses

c) BJT has lower switching losses and conduction losses

d) BJT has higher switching losses and conduction losses.

vii) A forward voltage may be applied to the thyristor after its

a) anode current reduces to zero

b) gate recovery time

c) reverse recovery time

d) anode voltage reduces to zero.

viii) In a 1-φ full converter, for discontinuous load current and extinction angle $\beta > \pi$, each SCR conducts for

a) α b) $\beta - \alpha$

c) β d) $\beta + \alpha$.

ix) A single phase half-wave controlled rectifier has input voltage $V_s = 400 \sin 314t$. It is connected on load. For a triggering angle of 60° for SCR, the average output voltage is

a) $400/\pi$

b) $300/\pi$

c) $240/\pi$

d) $200/\pi$.

x) In a single-pulse modulation of PWM inverters, third harmonic can be eliminated if pulse width is equal to

a) 30° b) 60°

c) 120° d) 150°.

xi) In UJT, maximum value of charging resistance is associated with

a) peak point

b) valley point

c) after valley point

d) any point between peak and valley points.

xii) In a 3-phase semiconverter for firing angle equal to 120° and extinction angle equal to 110°, each SCR and diode conduct respctively for

a) 30°, 60° b) 60, 60°

c) 90°, 30° d) 110°, 30°.

GROUP – B

(Short Answer Type Questions)

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

2. Draw and explain dynamic switching characteristics of power BJT.

3. Explain the two-transistor analogy of thyristor. Derive an equation for anode current. State the condition for turn-on. 2 + 2 + 1

4. What is the difference between the natural & forced commutations ? Explain the method of auxiliary commutation circuit.

5. a) Design the triggering circuit of PUT. The parameters of the PUT are supply voltage = 30 V, gate current = 1 mA. The frequency of oscillation f = 60 Hz. The pulse width is 50 μ sec, peak point voltage = 10 V.

   b) Explain the effect of gate voltage over it. 3 + 2

6. Explain the operating principle of TRIAC with suitable diagram.

GROUP – C

(Long Answer Type Questions)

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

7. a) Explain Boost and Cuk converters with neat circuit diagrams.

   b) What is advantageous between these two ? State briefly.

   c) A step-up chopper operating at 20 kHz has non-conductive time 20 micro-seconds. Calculate output voltage if input voltage is 100 V DC. 8 + 3 + 4

8. a) Thyristor is self latching device. Explain with the help of two-transistor analogy.

b) What is UJT ? What is the peak voltage of a UJT ? What is the valley point voltage of a UJT ? What is the intrinsic stand-off ratio of UJT ? What are the advantages of a PUT over a UJT ?

c) The UJT relaxation oscillator uses UJT for triggering an SCR. The UJT has the following characteristics :

Intrinsic stand-off ratio = 0·7, peak point voltage = 50 μA valley point voltage = 2 V, valley point current = 6 mA, supply voltage = 20 V, inter-base resistance = 7 K, emitter current = 2 mA. 5 + 5 + 5

9. a) Why is a three phase bridge control rectifier called a three pulse converter ?

b) In a single phase full-wave diode bridge rectifier, the diode has a reverse recovery time of 40 μ sec for an *a.c.* input voltage of 230 V. Determine the effect of reverse recovery time on the average output voltage for a supply frequency of

i) 50 Hz

ii) 2·5 kHz.

c) With the suitable waveform explain the operation of a single phase uncontrolled rectifier with R-L load. Deduce the expression of RMS and average value of output voltage.

d) 1-phase half controlled converter is with resistive load where the delay angle is $\frac{\pi}{4}$. Find the

i) rectifier efficiency

ii) form factor

iii) ripple factor. 1 + 4 + 5 + 5

10. a) What is cyclo-converter ? Describe the operating principle of a 1-φ to 1-φ step-up cyclo-converter with the help of bridge type configuration. Illustrate your answer with appropriate circuit and waveforms. The conduction of various SCR's should also be indicated in the diagram.

b) Draw the schematic circuit of a circulating current mode cyclo-converter and its operating waveforms.

c) What are the merits and demerits of a cyclo-converter compared to a variable frequency *a.c.* motor drive ?

7 + 4 + 4

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

a) UPS

b) IGBT

c) Flyback converter

d) Resonant series converter

e) Induction heating.

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