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 × 1 = 10

i) A BJT can be turned on by

a) switching off the supply

b) applying an appropriate bias voltage

c) removing the bias voltage

d) none of these.

ii) A G.T.O. can be turned off from conduction state by

a) removing the gate pulse

b) connecting a reversely charged capacitor across anode and cathode terminals

c) connecting an inductance between anode and cathode terminals

d) applying an appropriate negative gate pulse at the gate.

iii) A thyristor can be turned off by

a) connecting a reversely charged capacitor across its anode and cathode terminals

b) gradually decreasing the load current below the level of holding current

c) gradually decreasing the load current below the level of latching current

d) can be switched by connecting a snubber circuit across it terminals.

iv) A 1 – φ half-wave diode rectifier is connected to an *R – L* load. The diode will conduct only in the interval

a) $0 < \omega t \leq \pi$

b) $0 < \omega t \leq \beta$ where $\beta > \pi$ but less than 2π

c) $0 \leq \omega t \leq \beta$ where $\beta = 2\pi$

d) none of these.

v) *DC* chopper is used to

a) convert an *ac* voltage to *dc*

b) invert *dc* voltage to variable frequency *ac* voltage

c) convert a fixed *dc* voltage to a variable average *dc* output voltage

d) none of these.

vi) An inverter is used

a) to change the magnitude of *ac* output voltage like a transformer

b) to change the magnitude as well as frequency of the output voltage

c) to convert a fixed *dc* voltage to an *ac* voltage of desired frequency of fixed voltage

d) none of these.

vii) A *dc* bridge fully controlled converter feeding a *dc* motor is capable of regenerative braking if the converter is

a) a half controlled converter fed from an *ac* source

b) an uncontrolled converter fed from an *ac* source

c) fully controlled converter

d) none of these.

viii) A small inductance is used in series with thyristor to protect it against

a) high value of $\frac{di}{dt}$

b) overvoltage surges

c) overcurrent

d) thermal breakdown.

ix) A high power diode is made of

a) silicon only

b) germanium

c) only semiconductor material

d) a suitable superconducting material.

x) An R-C snubber circuit is connected across thyristor to protect

a) against high voltage switching surges

b) thermal breakdown

c) overcurrent breakdown

d) high d*v*/d*t*

at starting from off state.

GROUP – B

(Short Answer Type Questions)

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

2. Show the static V-I characteristics of a thyristor and explain briefly (i) forward break over voltage (ii) reverse break over voltage (iii) transition from off-state to on state (iv) effect of gate pulse on forward break over voltage.

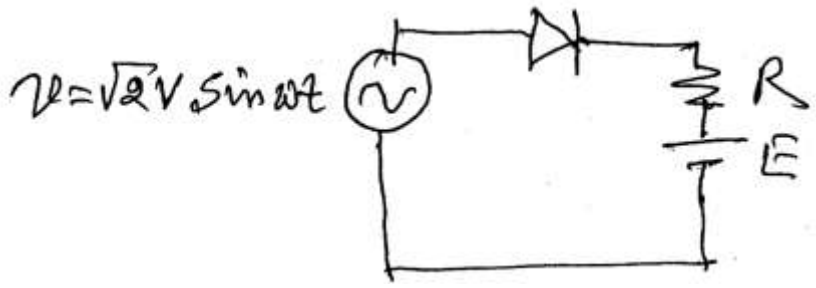
3. Explain the turn on phenomena in thyristor with a 2-transistor equivalent model. Explain regeneration effect from this model.

4. Briefly explain with necessary diagrams the operations of a G.T.O. Show a planner diagram and state how it differs from an ordinary thysistor.

5. Explain with necessary circuit diagram and waveforms of

input *ac* and output dc voltage of a 1 – φ half diode rectifier feeding a purely resistive load. Derive an expression for average *dc* output voltage.

6. A half-wave rectifier shown in the figure supplies a load consisting of a resistance connected in series with a battery bank of 100 V.



Given :

V = 110 V (r.m.s)

ω = 314 rad/sec

E = 100 V

a) Show in a diagram angle α at which the diode starts to conduct and angle γ = duration of conduction where γ = β – α, β being the extinction angle.

b) Sketch the nature of current waveform.

GROUP – C

(Long Answer Type Questions)

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

7. a) Define : (i) power factor (ii) distortion factor and (iii) displacement factor in connection with thyristor rectifier circuits. Show that

power factor = distortion factor × displacement factor.

b) Derive an expression of average *dc* output for a 3-phase half-wave controlled rectifier. Sketch the output voltage waveform.

8. Explain with a circuit, operation of a basic chopper feeding an R–L–E load with a free wheeling diode connected across

the R–L–E load. Sketch the nature of output voltage and load current waveform assuming continuous conduction. Show an expression for average current I_{av} assuming constant current during commutation.

9. Explain operation of a single phase inverter bridge with circuit diagram and show the nature of output current waveform for an R–L load.

10. a) Describe the various methods used to commutate thyristors in power circuits.

b) Explain working principle of operation of a 3-phase phase controlled bridge converter. What is commutation overlap in phase controlled converter ? Give necessary diagram.

11. Write short notes on any *two* of the following : 2 × 7.5

a) 3 – φ voltage source inverter (VSI)

b) Sinusoidal pulse width modulation in inverters

c) Control of induction motor by 3-phase *ac* controller.

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