



**MAULANA ABUL KALAM AZAD UNIVERSITY OF  
TECHNOLOGY, WEST BENGAL**

**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) In SCR, the latching current is
- a) equal to holding current
  - b) greater than holding current
  - c) less than holding current
  - d) twice the holding current.
- ii) If gate current of SCR is increased, then forward break over voltage will be
- a) increased
  - b) decreased
  - c) remain same
  - d) reduced to zero.

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- iii) In a three-phase semi-converter, the three SCRs are triggered at an interval of
- a)  $60^\circ$
  - b)  $90^\circ$
  - c)  $120^\circ$
  - d)  $180^\circ$ .
- iv) Chopper control of DC motor provides variation in
- a) input voltage
  - b) current
  - c) frequency
  - d) all of these.
- v) The range of firing angle control for R firing circuit is
- a)  $0^\circ$  to  $90^\circ$
  - b)  $0^\circ$  to  $180^\circ$
  - c)  $90^\circ$  to  $180^\circ$
  - d)  $180^\circ$  to  $360^\circ$ .
- vi) In an SCR, the magnitude of anode current will
- a) increase if gate current is increased
  - b) decrease if gate current is decreased
  - c) increase if gate current is decreased
  - d) remain unchanged with any variation in gate current.
- vii) PWM is used in inverters
- a) to control output voltage
  - b) to reduce harmonics in output
  - c) to compensate the variation in d.c. input
  - d) all of these.

- viii) In a commutation circuit employed to turn off an SCR, satisfactory turn off is obtained when
- circuit turn off time < device turn off time
  - circuit turn off time > device turn off time
  - circuit time constant > device turn off time
  - circuit time constant < device turn off time.
- ix) In a 3-phase 180° mode bridge inverter, the lowest order harmonics in the line to neutral output voltage ( fundamental frequency output = 50 Hz ) is
- 100 Hz
  - 150 Hz
  - 200 Hz
  - 250 Hz.
- x) A chopper, in which current remains positive but the voltage may be positive or negative, is known as
- Type-A
  - Type-B
  - Type-C
  - Type-D.
- xi) Presence of drift layer in a power semi-conductor device
- increases breakdown voltage rating
  - increases on state current rating
  - increases switching speed
  - decreases on state resistance.
- xii) The reverse recovery characteristics of a power diode is due to
- stored charge is depletion layer
  - stored change in semiconductor layers
  - stored charge in both depletion & semiconductor layers
  - forward current.

**GROUP - B**

**( Short Answer Type Questions )**

Answer any *three* of the following.  $3 \times 5 = 15$

- Explain with relevant waveforms, the principle of operation of an RC triggering circuit.
- With the help of relevant circuit diagram and waveforms, distinguish between voltage commutation and current commutation in an SCR circuit.
- Compare the merits & demerits of BJT, MOSFET & IGBT as power electronics switch.
- A 3-phase bridge inverter is fed from 200 V d.c. source. The inverter is operated in 180° conduction mode and it is supplying inductive, star connected load with  $R = 10 \Omega$  &  $L = 20 \text{ mH}$ . The inverter frequency is  $f_0 = 50 \text{ Hz}$ . Determine,
  - instantaneous line to line voltage & line current
  - RMS phase voltage & RMS line voltage.
- Briefly explain any method to control the output voltage and harmonic reduction in the inverter.

**GROUP - C**

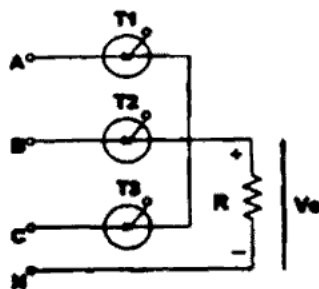
**( Long Answer Type Questions )**

Answer any *three* of the following.  $3 \times 15 = 45$

- Discuss with appropriate circuit diagram, the principle of operation of a three-phase bridge inverter connected with star connected resistive load. The period of conduction of each SCR is 180°. Draw phase & line voltage waveforms of the load. The sequence of firing of various SCRs should also be indicated in the diagram.
  - Explain the working of a resonant pulse inverter.

10 + 5

8. a) For a 3- $\phi$  controlled half-wave rectifier feeding load  $R$  as shown in the figure,



Draw the waveforms for the output voltages for both conditions given below and also show that the average output voltages are given by

$$V_0 = \begin{cases} \frac{3\sqrt{3}}{2\pi} V_{mp} \cos(\alpha) ; & \text{for } 0 < \alpha < \frac{\pi}{6} \\ \frac{3}{2\pi} V_{mp} \left[ 1 + \cos\left(\alpha + \frac{\pi}{6}\right) \right] ; & \text{for } \frac{\pi}{6} < \alpha < \frac{5\pi}{6} \end{cases}$$

where  $V_{mp}$  is the maximum value of phase voltage and  $\alpha$  is the firing angle delay.

- b) A single-phase half-wave controlled converter is operated from a 120 V, 50 Hz supply. Load resistance  $R = 10\Omega$ . If the average output voltage is 25% of the maximum possible average output voltage, determine : (i) firing angle, (ii) r.m.s. and average output current, (iii) average and r.m.s. SCR current.

10 + 5

9. a) With the help relevant circuit diagram & waveform, explain the principle of operation of DC-DC step down regulator. Deduce the expression of average & RMS value of output voltage.

- b) For type A chopper, d.c. source voltage = 200 V, load resistance =  $15\Omega$ . Assume a voltage drop of 1 V across the chopper when it is on. For a duty cycle of 0.4 and chopping frequency 1 kHz, calculate (i) average and r.m.s. values of output voltage, (ii) chopper efficiency, (iii) effective input resistance of the chopper.

7 + 8

10. a) What is a cycloconverter ? What benefits does it offer in comparison to inverter ?

- b) With the help of schematic diagram and relevant waveforms, explain the operation of 3-phase to 1-phase cycloconverter.

- c) What do you mean by blocked group operation & circulating current mode operation of a cycloconverter ?

5 + 5 + 5

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

- a) Speed control technique of AC motor
  - b) Static circuit breaker
  - c) HVDC transmission
  - d) Static VAR controller.
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