

**POWER ELECTRONICS
(ELEC 3202)**

Time Allotted : 3 hrs**Full Marks : 70***Figures out of the right margin indicate full marks.*

*Candidates are required to answer Group A and
any 5 (five) from Group B to E, taking at least one from each group.*

Candidates are required to give answer in their own words as far as practicable.

**Group - A
(Multiple Choice Type Questions)**

1. Choose the correct alternative for the following: **10 × 1 = 10**
- (i) 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°.
 - (ii) Which of the following semiconductor power device out of the following is not a current triggered device?
(a) SCR (b) GTO
(c) TRIAC (d) MOSFET.
 - (iii) RC snubber circuit is used to limit
(a) rate of rise of current in SCR
(b) rate of rise of voltage across SCR
(c) conduction period
(d) all of these.
 - (iv) A single-phase full bridge voltage source inverter has highly inductive load. For a constant source, the load current is
(a) square wave (b) triangular wave
(c) sine wave (d) pulse wave.
 - (v) A single-phase full converter can operate in
(a) 4 quadrants (b) 3 quadrants
(c) 2 quadrants (d) 1 quadrants.
 - (vi) Natural commutation can be used in
(a) DC circuits only (b) AC circuits only
(c) both AC and DC circuits (d) none of these.

- (vii) Cycloconverter converts
(a) AC voltage to DC voltage
(b) DC voltage to AC voltage
(c) AC voltage to AC voltage at same frequency
(d) AC voltage at supply frequency to AC voltage at load frequency.
- (viii) The advantage of 180° conduction mode of 3-phase inverter circuit over 120° conduction mode is that
(a) it needs less number of switches
(b) there is no paralleling of switches
(c) devices in series are not simultaneously switched
(d) load terminals are not left open during switching.
- (ix) Commutation overlap in the phase controlled AC to DC converters is due to
(a) load inductance
(b) harmonic content of load current
(c) switching operation in the converter
(d) source inductance.
- (x) For an SCR, di/dt protection is achieved through the use of
(a) R in series with SCR (b) RL in series with SCR
(c) L in series with SCR (d) L across SCR.

Group - B

2. (a) Write in detail about the basic structure of power diode. Also explain its reverse recovery characteristics.
(b) Describe in detail the RC triggering circuit for firing SCR.
(c) Define latching current and holding current of a thyristor.
- 6 + 5 + 1 = 12**
3. (a) A diode has a reverse recovery time of 2.5ms. If di/dt is 35 A/ms, Find the (i) stored charge Q_{rr} (ii) peak reverse current I_r.
(b) Draw the V-I characteristics of an SCR and point out (i) forward breakover voltage, (ii) reverse breakdown voltage, (iii) latching current, (iv) holding current.
(c) Explain in detail Class B commutation of thyristor, with necessary circuit diagram and waveform.

(2 + 2) + 1 + 7 = 12

Group – C

4. (a) Describe the operation of a full wave mid-point converter for R-L load with necessary equations and waveforms. Consider discontinuous mode of operation.
- (b) A DC battery is charged through a resistor. Derive an expression of the average value of charging current in terms of V_m , E and R on the assumption that SCR is fired continuously. For an AC source voltage of 230V, 50 Hz, find the value of average charging current for $R = 8\Omega$ and $E = 150V$. Also, find the power supplied to the battery.

$$6 + 6 = 12$$

5. (a) Differentiate between Class C and Class D chopper with necessary waveforms.
- (b) Derive an expression of ripple current for a boost chopper.
- (c) A 1-phase fully controlled thyristor bridge converter supplies a load consisting of R , L and E . The inductance L is so large that the output current may be considered to be constant. Assume the SCR to be ideal with the following data:
Supply voltage = 220 V, Load Resistance = 0.5 ohm & $L = 2$ mH with output current = 10 A.
Determine: (i) firing angle, if $E_b = 145V$ (ii) firing angle, if $E_b = -145V$.

$$6 + 3 + 3 = 12$$

Group – D

6. (a) Explain the operation of single-phase half bridge inverter for R-L load, along with necessary circuit diagram and relevant waveforms.
- (b) Explain the method of multiple pulse modulation with necessary equations.
- (c) What are the parameters on the basis of which the performance of an inverter is evaluated?

$$4 + 5 + 3 = 12$$

7. (a) Explain the operation of three-phase VSI for 120° mode of operation with waveforms for gate currents, phase voltages and line voltages.
- (b) Differentiate between 180° and 120° mode of conduction for a three-phase VSI.

$$10 + 2 = 12$$

Group – E

8. (a) A single-phase bridge type cycloconverter has input voltage of 230V, 50Hz and a load of $R = 10\Omega$. Output frequency is $1/3^{\text{rd}}$ input frequency. For a firing angle delay of 30° , calculate:
(i) RMS value of output voltage
(ii) RMS current of each thyristor
(iii) RMS current of each converter
(iv) input power factor.
- (b) Explain the operation of single-phase half-wave AC voltage controller for R load, along with necessary circuit diagram and relevant waveforms.

$$(2 + 2 + 1 + 1) + 6 = 12$$

9. (a) Explain in detail the operation of a single-phase to single-phase step-up mid point type cycloconverter.
- (b) Explain in detail the working principle of a switch mode power supply.
- (c) Define integral cycle control.

$$5 + 5 + 2 = 12$$