

POWER ELECTRONICS*Time: Three Hours**Maximum Marks: 100*

Answer five questions, taking ANY TWO from Group A, any two from Group B and all from Group C.

All parts of a question (a, b, etc.) should be answered at one place.

Answer should be brief and to-the-point and be supplemented with neat sketches.

Unnecessary long answer may result in loss of marks.

Any missing or wrong data may be assumed suitably giving proper justification.

Figures on the right-hand side margin indicate full marks.

Group A

1. (a) Explain, with a neat diagram, the (i) basic structure and working of IGBT 6
and (ii) its characteristics.
- (b) Write three important differences between BJT and power MOSFET. 6
- (c) Describe the working of a single-phase fully controlled bridge converter 8
with resistive load, and then explain how can it be operated in rectifier as
well inverter mode.
2. (a) Define Transformer-Utilization Factor(TUF) of a rectifier circuit. Compare 8
bridge rectifier and centre-tap rectifier for TUF.
- (b) A 220 V, 1.5 kW heater is energised from a 200 V, 50 Hz supply through a 6
diode. Find the power absorbed by the heater element, average value of the
load current, peak value of the diode current, and input power factor. Derive
the formula used.
- (c) A diode, with an internal resistance of 20 Ω , is to supply power to a resistive 6
load 1000 Ω from a 200 V supply. Calculate the (i) peak load current, (ii)
d.c. load current, (iii) d.c. diode voltage, and (iv) percentage regulation from
no load to full load.
3. (a) Explain GTO. Explain the turn-off and turn-on processes of a GTO with the 6

help of two transistor analogy.

- (b) Discuss briefly the voltage commutation and current commutation techniques used for the commutation of thyristors. 6
- (c) Enumerate various mechanisms by which thyristors can be triggered into conduction. 8
4. (a) What is a d.c. chopper? Explain its principle of operation. Where is it normally employed? 6
- (b) Classify choppers based on quadrant of operations. On the basis of 'four-quadrant' operation and configuration, explain the working of a dc-dc chopper. 8
- (c) A d.c. chopper (ideal), fed from 200 V supply, is connected to resistive load. The output voltage consists of rectangular pulses of 2 ms, with a chopping frequency of 200 Hz. Calculate the (i) ripple factor, (ii) average and rms values of output voltage, (iii) rms value of fundamental component of output voltage, (iv) a.c. ripple voltage, and (v) chopper efficiency, if the load being a resistance of 10 Ω . 6

Group B

5. (a) Define firing angle of a converter. Derive an expression for average and rms voltages of m- pulse phase controlled converter. 8
- (b) Explain, with the help of a neat power diagram and associated waveforms, the operation of a single-phase full converter in the rectifier mode with RLE load. Assume continuous conduction. 6
- (c) A 5 kW, 220 V, 1500 rpm separately excited d.c. motor speed is controlled using a single-phase full converter. If the a.c. supply voltage is 230 V, 50 Hz and the motor rated current is 20 A at near full load, find speed of the motor and its torque for firing angle (a) = 60° . Given armature resistance = 0.5 Ω and machine constant = 0.2 V/rpm. Assume continuous armature current. 6
6. (a) Calculate firing angles for a three-phase half-controlled and full-controlled bridge converters when they supply half of their maximum voltage. 6
- (b) For a three-phase fully controlled bridge converter, derive an expression for output voltage with resistive load. Assume continuous current condition. 8

- (c) What is step-up cycloconverter? Briefly explain the operation of a single phase bridge type step-up cycloconverter. Assume resistive load. 6
7. (a) What is an inverter? List a few industrial applications of inverters. Explain its principle of operation with the aid of a diagram. Write a note on domestic inverters. 6
- (b) Briefly explain the operation of McMurray half bridge single phase inverter. 8
- (c) A single-phase half bridge inverter, supplied from 200 V d.c. supply, is connected to a resistive load of 20Ω . Find (i) r.m.s. value of fundamental component of the output voltage and current, (ii) power delivered to the load due to fundamental component, (iii) peak and average current of each thyristor, (iv) PIV rating of each thyristor, (v) power delivered by each source due to fundamental component. 6
8. (a) Draw and explain the operation of a speed-control of a d.c. series motor by a single-phase full converter for continuous motor control. Draw a neat circuit diagram along with associated voltage and current waveforms. 8
- (b) Describe how the speed of a separately excited d.c. motor is controlled through the use of two 3-phase full converters. 6
- (c) Discuss how V/Hz control for a three-phase induction motor is similar to armature voltage control of a d.c. shunt motor. 6

Group C

9. Answer the following in brief: 20
- (i) Step-up choppers are used in
- (a) Induction heating
 - (b) Solar systems
 - (c) Induction motor starting
 - (d) Power quality applications
- (ii) Opto-coupler is used to
- (a) Reduce SCR turn-off time
 - (b) Protect IGBTs against dv/dt
 - (c) Regulate gating signal

- (d) isolate gating circuitry from power lines
- (iii) The best method for speed control of induction motors is to
- (a) Use inverters
 - (b) Cascade with another induction motor
 - (c) Use A.C. voltage regulator
 - (d) Use dual converter
- (iv) The advantage of using a free-wheeling diode with bridge type ac/dc converter is
- (a) Regenerative braking
 - (b) Reliable speed control
 - (c) Improved power factor
 - (d) Reduced cost of the system.
- (v) A single-phase half wave controlled rectifier has $400 \sin(314t)$ as the input voltage and K as the load. For a firing angle of 30° , the average output voltage is
- (a) 118.8 V
 - (b) 127.4 V
 - (c) 95.5 V
 - (d) 76.4 V.
- (vi) In a 3-phase controlled bridge rectifier, with an increase of overlap angle, the output d.c voltage
- (a) decreases
 - (b) increases
 - (c) does not change
 - (d) depends upon load inductance.
- (vii) With gate open, if the supply voltage exceeds the break over voltage of SCR, then SCR will conduct
- (a) false
 - (b) true
 - (c) for DC only
 - (d) for AC only.
- (viii) In a CSI if frequency of voltage input is f, then frequency of output voltage

- (a) f
 - (b) $f/2$
 - (c) $f/4$
 - (d) $f/8$
- (ix) The ratio of power handled by 18 SCRs to 36 SCRs 3-phase to three-phase cycloconverter for the same voltage and current rating Of SCR is
- (a) 1
 - (b) $1/2$
 - (c) $1/4$
 - (d) $1/8$
- (x) A step up chopper as source voltage and duty cycle of V and α . The output voltage for this chopper is
- (a) $V/(1 - \alpha)$
 - (b) $V(1 - \alpha)$
 - (c) $V/(1 + \alpha)$
 - (d) $V(1 + \alpha)$

(Refer our course material for answers)