

**POWER ELECTRONICS & DRIVES**  
**(AEI2204)**

**Time Allotted : 2½ hrs**

**Full Marks : 60**

*Figures out of the right margin indicate full marks.*

*Candidates are required to answer Group A and  
any 4 (four) from Group B to E, taking one from each group.*

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

**Group – A**

1. Answer any twelve:

**12 × 1 = 12**

*Choose the correct alternative for the following*

- (i) The average output voltage is maximum when SCR is triggered at  $\omega t =$ 
  - (a)  $\pi$
  - (b) 0
  - (c)  $\pi/2$
  - (d)  $\pi/4$
- (ii) The latching current is \_\_\_\_\_ the holding current.
  - (a) lower than
  - (b) higher than
  - (c) same as
  - (d) reverse of
- (iii) By using a freewheeling diode (FD) in a rectifier with RL load, the power consumed by the load
  - (a) increases
  - (b) decreases
  - (c) is not affected
  - (d) becomes zero
- (iv) For a half wave bridge inverter, the output voltage
  - (a)  $V_o = -V_s/2$  for  $0 < t < T/2$
  - (b)  $V_o = -V_s/2$  for  $T/2 < t < T$
  - (c)  $V_o = -V_s$  for  $0 < t < T/2$
  - (d)  $V_o = V_s/2$  for  $T/2 < t < T$
- (v) In current source inverters (CSIs), the output voltage's
  - (a) amplitude depends upon the load impedance
  - (b) waveform depends upon the load impedance
  - (c) amplitude as well as the nature of the waveform depends on the load
  - (d) both amplitude and waveform are independent of the load impedance
- (vi) The main advantage of sinusoidal PWM is
  - (a) Increases switching losses
  - (b) Reduction of harmonic distortion of in output voltage
  - (c) Reduction of output voltage
  - (d) Elimination of switching devices
- (vii) A step-up chopper has  $V_s$  as the source voltage and  $k$  as the duty cycle. The output voltage for this chopper is given by
  - (a)  $V_s (1 + k)$
  - (b)  $V_s / (1 - k)$
  - (c)  $V_s (1 - k)$
  - (d)  $V_s / (1 + k)$

- (viii) The values of duty cycle ( $\alpha$ ) in a chopper lies between  
 (a)  $0 < \alpha < 1$  (b)  $0 > \alpha > -1$   
 (c)  $0 \leq \alpha \leq 1$  (d)  $1 < \alpha < 100$
- (ix) In the method of speed control of an induction motor by inducing EMF in the rotor circuit, if the injected voltage is in the phase opposition to the induced rotor EMF, then  
 (a) The rotor resistance Increase (b) The rotor reactance increase  
 (c) The rotor reactance decrease (d) The rotor resistance decrease
- (x) The speed of a dc motor is mainly controlled by varying  
 (a) Armature voltage (b) Field flux  
 (c) Armature resistance (d) All of the above

*Fill in the blanks with the correct word*

- (xi) A triac is equivalent to two SCRs \_\_\_\_\_.
- (xii) A single phase full controlled bridge converter (B-2) uses \_\_\_\_\_.
- (xiii) A step-down chopper is also called as a \_\_\_\_\_ quadrant chopper.
- (xiv) In v/f control of three phase induction motor, \_\_\_\_\_ is fixed variable.
- (xv) An IGBT combines the advantages of \_\_\_\_\_.

### Group - B

2. (a) Discuss the different modes of operation of thyristor with the help of its static V-I characteristics. What is the effect of gate current on these characteristics?  
[[CO1](Understand/LOCQ)]
- (b) Define latching current and holding current.  
[[CO1](Remember/LOCQ)]
- (5 + 3) + 4 = 12**
3. (a) Explain the switching performance of BJT with relevant waveforms indicating clearly the turn on, turn off times and their components.  
[[CO1](Analyse/IOCQ)]
- (b) For a power BJT switching circuit operated in CE configuration,  $V_{CC} = 220V$ ,  $V_{CE, sat} = 1V$ ,  $R_L = 8\Omega$ ,  $R_B = 6\Omega$ . Assuming  $\beta = 15$ , determine (i) base current, (ii) minimum value of  $V_{BB}$  to ensure satisfactory operation, and (iii) power dissipation in BJT.  
[[CO1](Analyse/IOCQ)]
- 7 + 5 = 12**

### Group - C

4. (a) Briefly describe the expressions for the following performance parameters of single phase fully controlled bridge converter (i) form factor, (ii) input power factor, (iii) voltage ripple factor, (iv) current ripple factor and (v) Transformer Utilization Factor.  
[[CO2](Understand/LOCQ)]
- (b) Compare between Half-controlled converters & full controlled converters.  
[[CO2](Analyse/IOCQ)]
- (c) Mention the applications of controlled rectifiers.  
[[CO2](Apply/IOCQ)]
- 5 + 3 + 4 = 12**

5. (a) Explain with neat circuit diagram the 120° mode operation of 3-phase VSI. [[C04](Understand/LOCQ)]  
 (b) Why thyristors are not preferred for inverters? [[C01, C03] (Remember/LOCQ)]  
**10 + 2 = 12**

### Group - D

6. (a) What is duty cycle of a chopper? With neat diagram briefly explain the operation of a step down dc chopper. [[C03](Understand/LOCQ)]  
 (b) A step-up dc chopper has an input of 200 V and an output of 250 V. The blocking period in each cycle of operation is 0.6 ms. Determine the period of conduction in each cycle. If the input voltage is decreased to 150 V, determine the new period of conduction to maintain the same output voltage. [[C03](Analyse/IOCQ)]  
**(2 + 4) + (3 + 3) = 12**
7. (a) Explain the operating principle of step-down (buck) and step-up (boost) choppers. How does time ratio control regulate the output voltage? [[C03](Analyse/IOCQ)]  
 (b) Describe the circulating current mode and blocked group operation in cycloconverters. Why is circulating current sometimes necessary? [[C03](Analyse/IOCQ)]  
**6 + 6 = 12**

### Group - E

8. (a) What is meant by V/F control? What are the advantages of V/F control? [[C06](Remember/LOCQ)]  
 (b) State two basic speed control schemes of DC shunt motor? Why is the starting current high in a DC motor? Why series motor cannot be started on no-load? [[C05](Remember/LOCQ)]  
**(3 + 3) + (2 + 2 + 2) = 12**
9. (a) A 230V, 30A, 1000 rpm separately excited dc motor having an armature resistance of 0.7Ω and inductance of 50 mH. Motor is controlled in regenerative braking by a chopper operating at 800 Hz from a dc source of 230 V. Assuming continuous conduction,  
 (i) Calculate the duty ratio of the chopper for rated torque and the speed of 800 rpm.  
 (ii) What will be the motor speed for duty ratio of 0.6 and rated motor torque. [[C05](Analyse/IOCQ)]  
 (b) Explain the principle of Slip power recovery scheme used for speed control of Induction Motor. [[C05](Understand/LOCQ)]  
**6 + 6 = 12**

---

|                         |       |       |      |
|-------------------------|-------|-------|------|
| Cognition Level         | LOCQ  | IOCQ  | HOCQ |
| Percentage distribution | 55.21 | 44.79 | 0    |

