# DECEMBER 2006

**Code: A-26**                                                      **Subject: POWER ELECTRONICS**
**Time: 3 Hours**                                                                      **Max. Marks: 100**

**NOTE: There are 9 Questions in all.**
- **Question 1 is compulsory and carries 20 marks. Answer to Q. 1. must be written in the space provided for it in the answer book supplied and nowhere else.**
- **Out of the remaining EIGHT Questions answer any FIVE Questions. Each question carries 16 marks.**
- **Any required data not explicitly given, may be suitably assumed and stated.**

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**Q.1**    **Choose the correct or best alternative in the following:**                    **(2x10)**

a.   If the gate current of an SCR increases, the forward breakdown voltage will _____ .

   **(A)** decrease                             **(B)** not be affected
   **(C)** increase                             **(D)** become zero

b.   In a parallel resonance turn-off circuit with a critical damping value $\left(R^2 = 4L/C\right)$ where R is load resistance, this R_____

   **(A)** Can be lower than the critical damping value.
   **(B)** Can be lower or higher than the critical damping value.
   **(C)** Can be higher than the critical damping value.
   **(D)** Can be equal to the critical damping value.

c.   In a three-phase full converter, with a supply frequency f, the output voltage pulses are at a frequency equal to _____ .

   **(A)** f                                     **(B)** 2f
   **(C)** 3f                                    **(D)** 6f

d.   The gate-source voltage of a power MOSFET to switch it on, will be _____

   **(A)** +5 V                                  **(B)** +8 V
   **(C)** +20 V                                 **(D)** +12 to 15 V

e.   The duty cycle of a chopper circuit is expressed as _____ .

   **(A)** $t_{ON} + t_{OFF}$                    **(B)** $\dfrac{t_{ON}/t_{OFF} + t_{ON}}{t_{ON} + t_{OFF}}$

   **(C)** $\dfrac{1}{t_{ON} + t_{OFF}}$         **(D)** $\dfrac{t_{ON} + t_{OFF}}{t_{ON}}$

f.   A phase controlled cycloconverter employs _____.

   (A) Load commutation          (B) Line commutation
   (C) Forced commutation        (D) No commutation

g.   A single-phase voltage controller is connected to a load of resistance $20\Omega$ and a supply of 200 sin (314 t) volts. For a firing angle of $90°$, the average thyristor current in amperes is _____.

   (A) 10                        (B) $10/\pi$

   (C) $\dfrac{5\sqrt{2}}{\pi}$  (D) $\dfrac{5}{\sqrt{2}}$

h.   One method for the voltage control of an inverter is to use a phase controlled rectifier followed by a filter. This filer has the disadvantage namely, it_____

   (A) increases the cost of the circuit.   (B) introduces high order harmonics.
   (C) introduces low order harmonics.      (D) makes the performance slightly
                                                sluggish.

i.   In a single-phase semi-converter, for continuous conduction, a free wheeling diode conducts for an angle equal to _____

   (A) $\alpha$                  (B) $\pi - \alpha$
   (C) $\pi$                     (D) $\alpha - \pi$

j.   Two-quadrant operation of a dc-dc converter is reuired for _____ of a DC motor.

   (A) Rotor voltage control     (B) stator voltage control
   (C) power and regenerative braking   (D) current control

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**Answer any FIVE Questions out of EIGHT Questions.**
**Each question carries 16 marks.**

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**Q.2**   a.   Explain the operation of the PNPN device in terms of the two-transistor anology; Also derive the equation for anode current.                **(5+4)**

   b.   An SCR having a $\dfrac{dv}{dt}$ rating of $200\,V/\mu sec$ and a $\dfrac{di}{dt}$ rating of $100\,A/\mu sec$ is connected to a 200 V DC source having a source resistance of $1\Omega$. Calculate the values for the elements of snubber circuit.                **(7)**

**Q.3**   a.   Describe the operation of a single-phase thyristor converter with a resistive load and with the help of a circuit diagram and waveforms. Also obtain the expressions for $V_{dc}$ and $V_{rms}$ of the output

voltage.        **(6+4)**

b.   A three phase fully controlled bridge rectifier is operating from a 400 V,   50 Hz supply.  The thyristors are fired at $\alpha = \dfrac{\pi}{4}$ .  With a free wheeling diode across the load, find the average output voltage for $\alpha = 45°$ as well as for $\alpha = 75°$ .                                                                                               **(3+3)**

**Q.4**   a.   Give the circuit arrangement of a Buck-Boost regulator and explain its operation with suitable waveforms.                                                **(3+6)**

b.   The input and output of a step-up chopper are 200 v and 600 v.  If the conducting time of thyristor is $200\mu sec$ , compute:
(i)   The chopping frequency
       (ii)   If the pulse width is halved for constant frequency of operation, find the new output voltage.                                                              **(7)**

**Q.5**   a.   Differentiate between self commutation and impulse commutation with relevant circuit diagrams and waveforms.                                                **(5+5)**

b.    Explain with suitable examples, why line-side commutation is different from load-side commutation.                                                                **(6)**

**Q.6**   a.   With suitable diagrams, explain the operation of a three-phase bi-directional delta-connected controller.                                                          **(10)**

b.   A single phase half-wave ac regulator using one SCR in anti-parallel with a diode, feeds 1 KW, 230 V heater.   Find the load power for a firing angle of $45°$ .                                                                                           **(6)**

**Q.7**   a.   With suitable waveforms, explain the operation of (i) a three phase and    (ii) a single phase cycloconverter .
**(9)**

b.   What are the commonly used techniques for voltage control of a single phase inverter?  Explain the single pulse-width modulation method.          **(2+5)**

**Q.8**   a.   A single phase full-bridge inverter has a resistive load of $10\Omega$ with a DC input voltage V = 220 V.  Find
             (i)       the rms output voltage at the fundamental frequency.
             (ii)      The output power, $P_o$ .
             (iii)     The total harmonic distortion.                                          **(6)**

b.   Explain the various operating modes of a dc motor for variable speed applications.          **(10)**

**Q.9**      Write explanatory notes on any **TWO** of the following:-

    (i)       Closed loop control of an Induction motor.

    (ii)      Series and parallel operation of thyristors.

    (iii)     PUT.

    (iv)     Dual converter.　　　　　　　　　　　　　　　　　　**($8 \times 2$)**