Code: AE26 **Subject: POWER ELECTRONICS**

AMIETE – ET (OLD SCHEME)

Time: 3 Hours **DECEMBER 2011** Max. Marks: 100

NOTE: There are 9 Questions in all.

- **Please write your Roll No. at the space provided on each page immediately after receiving the Question Paper.**
- **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.**
- **The answer sheet for the Q.1 will be collected by the invigilator after 45 Minutes of the commencement of the examination.**
- **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.**

Q.1 **Choose the correct or the best alternative in the following:** (2×10)

a. As compared to power MOSFET, a BJT has

 (A) Lower switching losses but higher conduction loss
 (B) Higher switching losses and higher conduction loss
 (C) Higher switching losses but lower conduction loss
 (D) Lower switching losses and lower conduction loss.

b. An SCR can be brought to forward conducting state with gate-circuit open when the applied voltage exceeds.

 (A) The forward break over voltage **(B)** Reverse breakdown voltage.
 (C) 1.5 V **(D)** Peak non-repetitive off-state voltage

c. A single-phase full wave midpoint thyristor converter uses a 230/200 V transformer with centre tap on the secondary side. The PIV per thyristor is.

 (A) 100 V **(B)** 141.4 V
 (C) 200 V **(D)** 282.8 V

d. The three-phase ac to dc converter which requires neutral point connection is

 (A) 3-phase semi-converter **(B)** 3-phase full converter
 (C) 3-phase half wave converter **(D)** 3-phase full converter with diodes

e. In dc chopper, for chopping period T, the output voltage can be controlled by FM by varying

 (A) T keeping T_{on} constant **(B)** T keeping T_{off} constant
 (C) T_{on} keeping T constant **(D)** Both **(A)** & **(B)**

f. In a CSI, if frequency of output voltage is f Hz, then frequency of voltage input to CSI is

(A) f   (B) 2f
(C) f/2   (D) 3f

g. In a single-phase voltage controller with RL load, α is the firing angle, $\emptyset$ is the load phase angle and ß is the extinction angle. For this voltage controller, output power can be controlled if $\alpha > \emptyset$ and

(A) $(ß-\alpha) = \pi$ (B) $(ß-\alpha) < \pi$
(C) $ß > \pi$ (D) Both (B) and (C)

h. The cycloconverter (CCs) require natural or forced commutation as under

(A) Natural commutation in both step-up and step down CCs
(B) Forced commutation in both step-up and step down CCs
(C) Forced commutation in step-up CCs
(D) Forced commutation in step-down CCs

i. The number of thyristor required for single-phase to single phase cycloconverter of the mid-point type and for three to three-phase 3 pulse type cycloconverter are respectively

(A) 4,6   (B) 8,18
(C) 4,18   (D) 4,36

j. A single phase full bridge inverter can operate in load commutation mode in case load consists of

(A) RL   (B) RLC underdamped.
(C) RLC overdamped   (D) RLC critically damped

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

Q.2   a. What are the characteristics of an ideal power-switching device? Compare the characteristics of IGBT and MOSFET. Draw the transfer characteristics and switching characteristics of IGBT.   **(12)**

       b. Define the following terms for S.C.R.:
          (i) Latching current,
          (ii) Holding current,
          (iii) di/dt rating,
          (iv) dv/dt rating.   **(4)**

Q.3   a. An RL load is fed from single-phase supply through a thyristor. Derive an expression for load current in terms of supply voltage, frequency, R, L etc. Indicate the time limits during which this solution is applicable.   **(8)**

b. Explain the need of commutation in thyristor circuit. What are the different methods of commutation schemes? Discuss one of them, with a neat schematic and waveforms. **(8)**

Q.4 a. Describe the various types of chopper configurations and control strategies with appropriate waveforms. Also explain multi-quadrant chopper. **(8)**

b. What techniques are involved in voltage control of single phase inverters? Explain any one of them with appropriate waveform. **(8)**

Q.5 a. In detail, explain three-phase to single-phase cycloconverters with circuit diagram and appropriate waveform associated. **(8)**

b. An ac-dc converter steps down the voltage through a transformer and supplies the load through a bridge rectifier. Design a 60Hz power transformer of the specifications: primary voltage $V_1 = 120V$, 60Hz (square wave), secondary voltage output $V_0 = 40V$, and secondary output current $I_0 = 6.5A$. Assume transformer efficiency $\eta = 95\%$ and window factor $K_u = 0.4$. Use E-Core. **(8)**

Q.6 a. A converter is feeding an RL load as shown in Fig.1 with $V_s = 220V, R = 5\Omega$, L=7.5mH, f = 1kHz, k = 0.5, and E = 0 V. Calculate

(i)   The minimum instantaneous load current I_1

(ii) The peak instantaneous load current I_2

(iii) The maximum peak-to-peak load ripple current

(iv) The average value of load current I_a **(4×2 = 8)**

Fig.1
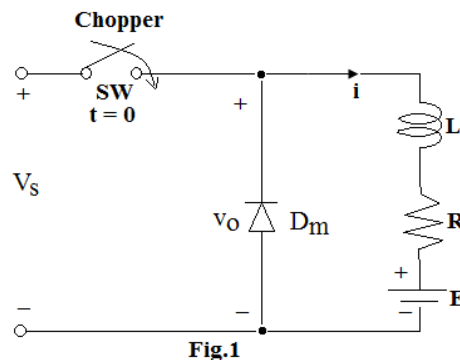
b. What is the principle of AC phase controller with proper circuit diagram? Give the RMS output voltage and average value of output voltage. **(8)**

Q.7 a. A single-phase 230 V, 1 kW heater is connected across 1-phase, 230 V, 50 Hz supply through an SCR. For firing angle delays of 45° and 90°, calculate the   power absorbed in the heater element. **(8)**

b. Explain detailed working of voltage commutated chopper with circuit diagram and associated waveform. **(8)**

Q.8 a. Describe the working of two stage sequence (transformer tap) control of voltage controllers with both R load and RL load. What are the advantages of this controller over single–phase full wave voltage controller? **(8)**

   b. What is blocked group operation? Explain it with circuit diagram and waveforms if necessary. **(8)**

Q.9 Write short note on: (Any **TWO**)

   (i) Commutation circuit design.
   (ii) Effects of Source and Load Inductances
   (iii) Circulating current mode **(8×2)**