ROLL NO. _____

Code: AE123 **Subject: POWER ELECTRONICS**

AMIETE – ET (New Scheme)

Time: 3 Hours **December - 2017** **Max. Marks: 100**

PLEASE WRITE YOUR ROLL NO. AT THE SPACE PROVIDED ON EACH PAGE IMMEDIATELY AFTER RECEIVING THE QUESTION PAPER.

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.**
- **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. RCD snubber circuit is used to limit rate of rise of
(A) bi-directional current in SCR
(B) voltage across SCR
(C) uni-directional current in SCR
(D) All of these

b. In an SCR latching current is defined
(A) with gate triggering
(B) without gate triggering
(C) for reverse recovery process
(D) for freewheeling process

c. Turn-on time of SCR in series with RL circuit can be reduced by
(A) increasing circuit resistance R **(B)** decreasing R
(C) increasing circuit inductance L **(D)** decreasing L

d. For designing the inductor used in a DC-DC converter,
(A) switching frequency is not required
(B) switching frequency is required
(C) both switching frequency and current ripple are required
(D) current ripple values are not required

e. In 180^0 conduction mode of three phase VSI, the percentage of third harmonics existing in the line voltage is
(A) 75% **(B)** 50%
(C) 65% **(D)** 0%

f. For continuous conduction, each thyristor pair of a two pulse full converter should conduct for
(A) π **(B)** $\pi-\alpha$
(C) $\pi+\alpha$ **(D)** α

g. A CSI is normally employed with
(A) converter grade SCRs
(B) inverter grade SCRs
(C) small value of capacitance for realising current source
(D) larger value of capacitance for realising current source

h. The output voltage of a chopper under freewheeling mode will
(A) vary from $+V_d$ to $-V_d$ **(B)** vary from 0 to $+V_d$
(C) vary from 0 to $-V_d$ **(D)** will be zero

i. Schottky diode has
(A) pn junction **(B)** pnp junction
(C) low forward voltage drop **(D)** high forward voltage drop

j. In SMPS filter inductor size is small due to high
(A) current flow **(B)** voltage
(C) switching frequency **(D)** current ripple

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

Q.2 a. Explain V-I characteristics and switching characteristics of a power diode. **(5+5)**

b. Explain the switching operation of IGBT. **(6)**

Q.3 a. Explain the V-I characteristics of thyristor. **(6)**

b. An SCR has V_{DRM} = 600 V, $\left(\frac{dv}{dt}\right)_{max} = 25\,V/\mu s$ and $\left(\frac{di}{dt}\right)_{max} = 30\,A/\mu s$. It is used to energize a 100 Ω resistive load. Find the minimum values for an RC snubber circuit to avoid unintentional triggering. **(6)**

c. How SCRs are connected in parallel? Explain with necessary diagrams. **(4)**

Q.4 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 degrees and 90 degrees, calculate the power absorbed in the heater element. Derive the necessary expressions. **(10)**

b. Prove that magnitude of average output voltage will be decreasing for a full converter operated with source inductance voltage. **(6)**

Q.5 Prove that three phase semi-converter can act as six pulse as well as three pulse converter. **(16)**

Q.6 For a buck converter with resistive load, derive the following by considering source voltage (V_s), turn on time (T_{on}), turn off time (T_{off}), duty cycle (α), output voltage (V_o) and resistive load (R):

(i) Average output voltage and current **(2)**
(ii) Output current at the instant of commutation. **(2)**
(iii) Average and rms freewheeling diode currents **(2+2)**
(iv) Rms value of output voltage **(2)**
(v) Rms and average thyristor currents **(2+2)**
(vi) Effective input resistance of the chopper **(2)**

Q.7 For a single phase full bridge inverter, V_s=230 V dc, T=1 ms. The series connected RLC load consists of R = 1 Ω, ωL= 6 Ω, $(\omega C)^{-1}$= 7 Ω

(i) Sketch the waveforms for load voltage (v_o), fundamental component of source current (i_{o1}), source current (i_s), and voltage across thyristor 1. Indicate the device under conduction during different intervals of one cycle. **(10)**
(ii) Find the power delivered to load due to fundamental component. **(3)**
(iii) Check whether forced commutation is required or not. Take thyristor turn off time as 100 μs. **(3)**

Q.8 a. Explain with relevant circuit diagram and waveforms for three -phase ac voltage controller. **(8)**

b. A three phase to single phase cycloconverter employs three pulse positive and negative group converters. Each converter is supplied from delta/star transformer with per phase turns ratio of 2:1. The supply voltage is 400 V, 50 Hz. The RL load has R= 2 Ohms and at low frequency inductive reactance= 1.5 Ohms. In order to account for commutation overlap and thyristor turn-off time, the firing angle in the inversion mode should not exceed 160 degrees. Compute

(i) The value of the fundamental rms output voltage,
(ii) Output power **(4+4)**

Q.9 a. Two six pulse converters are used in bipolar HVDC transmission system. The ac systems are three phase 11 kV, 50 Hz. The input transformers have a leakage inductance of 10 mH per phase. The current in dc line is 300A. The inverter marginal angle is 20 degrees. Resistance of each dc transmission line is 1 Ohm. Calculate the firing angle of the rectifier and its output voltage. **(3+3)**

b. Explain the operation and working of a half bridge and full bridge SMPS with the help of a circuit diagram. **(10)**