

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SECOND SEMESTER M.TECH DEGREE EXAMINATION, MAY 2016

Electrical and Electronics Engineering

(Power Control and Drives)

01EE6502 Design Principles of Power Converters

Max. Marks: 60

Duration: 3 Hours

Answer any two full questions from each part.

Part A

1. Design an inductor for buck converter configuration with the following specifications:
Output voltage, $V_o = 3.3V$
Output current, $I_o = 5A$
Switching frequency, $f_s = 20 \text{ kHz}$
Input voltage, $V_i = 10V \pm 10\%$
Diode voltage drop, $V_d = 1V$
Operating flux density, $B_{ac} = 0.05T$
Window utilization factor, $K_u = 0.29$
Current density, $J = 433 \text{ A/cm}^2$ (9)
2. Design a heat sink with forced convection, for a three phase sinusoidal PWM inverter delivering a load current of 175A (peak) at 0.8 pf. The dc bus voltage is 600V, Switching frequency = 2 kHz.

The datasheet parameters of the dual IGBT module are as follows:

$T_{jmax} = 125^\circ C$, $T_{ambient} = 50^\circ C$

IGBT saturation voltage drop $V_{CE(sat)} @ 175A = 1.4V$

Total Turn on and turn off switching energy per pulse = 58 mJ

Forward voltage drop of the diode @ 175A = 1.45V

Diode peak recovery current = 300A

Diode reverse recovery time = 102nS

$R_{\theta jc}(Q) = 0.085^\circ C/W$ per IGBT $\frac{1}{2}$ module

$R_{\theta jc}(D) = 0.15^\circ C/W$ per FWD $\frac{1}{2}$ module

Contact thermal resistance $R_{\theta cl} = 0.02^\circ C/W$ per $\frac{1}{2}$ module with thermal grease

Cooling fan specifications:

Size 60mm X 60mm

Airflow = 12.8CFM (9)

3. a) Write short notes on
i) Ferrite cores (5)
ii) Powdered iron cores (5)
b) Explain different types of heat transfer methods. (4)

Part B

4. What are ground loops? What are the problems associated with ground loops in converter circuits? Explain the methods to overcome the ground loop noise. (9)
5. Explain the working of the MOSFET driver circuit with totem pole connection, using relevant diagrams. (9)
6. a) Explain the necessity of driver circuit in an inverter. (5)
b) Draw and explain any two commonly used snubber circuits. (4)

Part C

7. Explain over current protection using de-saturation scheme (12)
8. Explain conductive and radiated EMI. Elaborate on the methods to minimize EMI. (12)
9. a) Explain over temperature protection used with IPMs. (6)
b) Explain common mode filters to suppress electromagnetic interference. (6)
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