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M.E./M.Tech. Degree Examinations, January 2017

First Semester

POWER ELECTRONICS AND DRIVES

PD16104 - ADVANCED POWER SEMICONDUCTOR DEVICES

(Regulation 2016)

QP Code: 671761

Time: Three hours

Maximum : 100 marks

Answer **ALL** questions

PART A - (10 X 2 = 20 Marks)

1. How is the 'Safe Operating Area' of a switch demarcated?
2. Write down the various factors which affect conduction and switching losses.
3. What is the correlation between NTC and secondary breakdown?
4. Distinguish between Converter and Inverter grade thyristors.
5. Draw the static characteristics of a MOSFET, by identifying the different regions.
6. Explain the principle of an IGCT.
7. Compare opto-isolator with pulse transformer isolation.
8. What do you mean by crow-bar firing?
9. Distinguish between thermal resistance and thermal impedance.
10. What are the different types of heat sink mounting?

PART B - (5 X16 = 80 Marks)

11. (a) (i) How do you choose a power device for an application? Explain with examples. (8)
- (ii) How is the rating of a power diode increased as compared to a signal diode? (8)
- (b) (i) "Switching of a power device causes electro-magnetic interference"; Comment on it. (8)
- (ii) Explain the reverse recovery phenomenon in diodes. (8)
12. (a) (i) Draw the switching characteristics of Power BJTs and discuss on it. (8)
- (ii) Using a two transistor model, explain the static characteristics of a thyristor. (8)

(OR)

- (b) (i) A power BJT has a minimum current gain of 8. The load resistance is 11Ω . The supply voltage is 200V and the input voltage to the base circuit is 10V. If $V_{CE(sat)}$ is 1V and $V_{BE(sat)}$ is 1.5V, find (a) the value of resistance to be added in the base circuit, for an over drive factor of 5 (b) the forced current gain and (c) the power loss in the transistor. (8)
- (ii) Obtain an expression for de-rating factor of thyristors connected in series under (a) steady state and (b) turn-off condition. (8)
13. (a) (i) Compare the salient features of an SCR, MOSFET and BJT. (8)
- (ii) Two MOSFETs M1 and M2 are connected in parallel and carry a total current of 20A. The drain to source voltage of M1 is 2.5V and that of M2 is 3V. Determine the drain current of each switch if the current sharing series resistances are (a) 0.3Ω for M1 and 0.2Ω for M2 and (b) the resistances are 0.5Ω each for M1 and M2. (8)
- (OR)**
- (b) (i) Discuss the transient characteristics of an IGBT and its ‘current tail’ problem. (8)
- (ii) Describe the construction and features of a GTO which enables it to turn off with a negative gate pulse. (8)
14. (a) (i) Explain a typical gate drive circuit for an SCR. (8)
- (ii) Explain proportional base and anti-saturation control of a BJT driver circuit. (8)
- (OR)**
- (b) (i) Write a note on “over voltage” and “over current” protection of a power switch. (8)
- (ii) How does a snubber alter the profile of switch voltage/ current during switching? (8)
15. (a) (i) Describe the different methods of cooling semiconductor devices. (8)
- (ii) Explain the design of a heat sink for specific application? (8)
- (OR)**
- (b) (i) Explain the different types of heat sinks with their merits and demerits. (8)
- (ii) A power device used in a circuit has a steady state thermal impedance of $0.3^{\circ}\text{C}/\text{W}$ and a transient thermal impedance of $0.05^{\circ}\text{C}/\text{W}$ for 100ms. The ambient temperature is 40°C and the maximum permitted junction temperature is 125°C . Following a steady power loss of 200W, how much of additional pulsed power loss can the device withstand for 100ms duration? (8)