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Question Paper Code : 11184

M.E./M.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2019.

First Semester

Power Electronics and Drives

PX 5101 — POWER SEMICONDUCTOR DEVICES

(Regulations 2017)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Sketch the safe operating area of power MOSFET and power IGBT.

2. What do you infer from maximum peak reverse current in diode reverse characteristics?

3. Draw the two transistor analogy model of a thyristor.

4. What is meant by converter grade and inverter grade of thyristor?

5. Draw the switching characteristics of IGBT.

6. Why MOSFET is called as voltage controlled device?

7. Sketch an optocoupler circuit and how it is being used in power semiconductor circuits.

8. What is the purpose of using pulse transformer in the gate drive circuit of thyristor and how it is done?

9. Compare conduction and convection in thermal protection.

10. Draw the electrical analog circuit of heat transfer in the power device without heat sink.

PART B — (5 × 13 = 65 marks)

11. (a) Derive the reverse recovery charge (Q_{RR}) during the turn-off period of a diode. (13)

Or

(b) Explain different types of losses in power diode incorporating V and I characteristics with respect to time. Derive the expression for the total power loss in power diode. (13)

12. (a) Explain the principle of operation of thyristors with the help of different operating regions. (13)

Or

(b) (i) Compare GTO, MCT and RCT in terms of switching characteristics. (7)

(ii) Draw and explain the switching characteristics of BJT. (6)

13. (a) With the help of a neat sketch, explain the construction and principle of operation of IGBT. (13)

Or

(b) Explain the switching characteristics of enhancement type power MOSFET with parasitic model. (13)

14. (a) Design a gate driver circuit for thyristor to trigger firing pulses ranging from 45° - 180°. (13)

Or

(b) Design a snubber circuit protection scheme of a thyristor to minimize $\frac{di}{dt}$ effects. (13)

15. (a) Explain the concept of thermal resistance in semiconductor with thermal dissipation equivalent circuit. (13)

Or

(b) Describe phase cooling in power semiconductor devices with the neat sketches. (13)

PART C — (1 × 15 = 15 marks)

16. (a) Consider a single switch, single-input power processing circuit given in figure below. Assume the source voltage. $v_s(t)$ is a triangular waveform with a peak voltage V_p and the frequency $f = 1/T$. Assume the switch is ideal and initially off, and its control works in such a way that it toggles every time $v_s(t)$ crosses zero. Use $V_p = 12V$, $R = 10\Omega$ and $T = 1ms$.

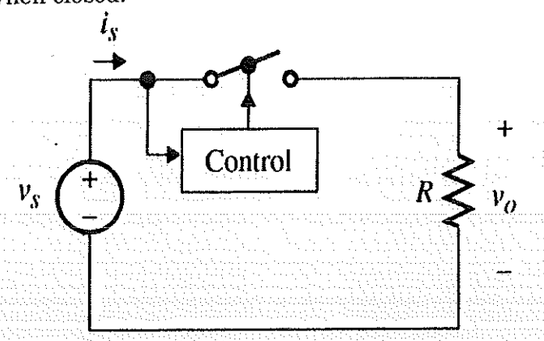
(i) sketch the waveforms for i_s and v_o

(ii) Calculate the average and rms values for the output voltage.

(iii) Calculate the average input power, average output power and efficiency

(iv) Repeat parts (i)-(iii) by assuming T=1 μs.

(v) Repeat parts (i)-(iv) by assuming the switch has 1V voltage drop when closed. (15)



Or

(b) Consider the switching circuit with the series snubber R_s–C_s, network connected across the diode as shown below. Assume the diode switching characteristic curve is given by the figure(b) below. And the switch is ideal.

(i) Derive the expression for all the branch currents and V_D and sketch them

(ii) Derive the expression for the capacitor Cs that is needed.

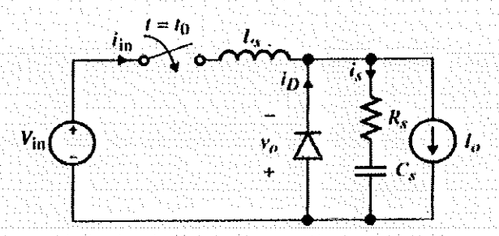


figure (i)

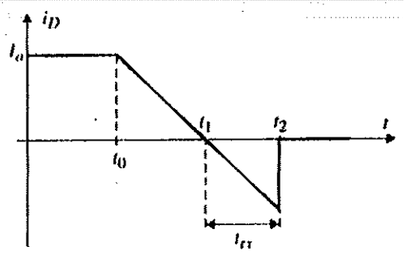


figure (ii)