Quiz 3, Power Semiconductors, 2003_4, EE4001

Answer all questions.

Name: **Student Number:**

1. In terms of n, n+, n-, p, p+, p-, sketch the four layers of the VDMOSFET going from source to drain.

2. Sketch the electrical symbol of the n-channel IGBT and identify the terminals of the device.

3. A MOSFET operates in a buck converter with a 5 V dc bus, and experiences an additional 1 V spike due to leakage inductance. Using typical derating guidelines, what voltage silicon would you recommend to the nearest volt?

4. An IGBT has a maximum specified junction temperature of 150 °C. The part is free standing without a heatsink, and the total thermal resistance from the junction to the ambient is specified as $\theta_{J\text{-}A}$ = 40 °C/W. Under typical derating guidelines, how much power can you safely dissipate in the device?

5. Would you use a MOSFET, IGBT, BJT, or SCR, as the power switch in a 2 MHz, 12 V input, 1.8 V output, buck converter for local regulation on a Pentium processor.

6. What is the purpose of the source-body metallization in the power MOSFET?

7. A power MOSFET has a threshold voltage $V_{GS(th)}$ = 4 V, and conducts drain current I_D = 10 A at $V_{GS(th)}$ = 5 V. What is the transconductance of the device?

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8. Which characteristic of the power MOSFET increases significantly with temperature, thus worsening the conduction losses?

9. Under hardswitching conditions, what happens the gate voltage during the charge or discharge of the Miller capacitance?

10. An IGBT is switching at 10 kHz. Turn-on energy loss equals the energy turn-off loss equals 2.5 mJ, and the conduction loss equals the combined switching loss. What is the temperature of the junction when attached to a 60 °C heatsink with a $\theta_{J\text{-}C}$ = 0.2 °C/W?

11. Why does the Miller capacitance of power MOSFET rapidly discharge during the reverse recovery of the power diode?

12. Both the power MOSFET and IGBT have lightly doped drift regions. Why does the IGBT have a tail current problem?

13. What advantages make the IGBT a more preferable device to the MOSFET for high-voltage operation?

14. Why is the vertically diffused structure commonly used in power semiconductors?

15. Why are MOSFETs typically undesirable at high voltages (>500V)?

16. Sketch the model of the MOSFET operating in the active region.