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VASAVI COLLEGE OF ENGINEERING *(Autonomous)*, HYDERABAD
M.E. I Year (ECE) I-Semester (Make Up) Examinations, May-2015
(Embedded Systems & VLSI Design)

Physics of Semiconductor Devices

Time: 3 hours Max. Marks: 70

Note: Answer ALL questions in Part-A and any FIVE questions from Part-B

Part-A (10 X 2=20 Marks)

1. List some of the important differences between metals, semiconductors and insulators.
2. A piece of Si is doped such that the concentration of free electrons (n) is 1.5 x 10^{15}cm^{-3}. Estimate the concentration of holes (p) in this sample if the intrinsic carrier concentration ($n_i = p_i$) of Si is 1.5 x 10^{10} cm^{-3} at room temperature (300 K).
3. Explain Zener break down in semiconductor diodes. How is it different from Avalanche break down?
4. Draw the energy band diagram of an n-p-n transistor when it is biased in its active region.
5. Mention some important structural parameters that can influence emitter efficiency, base transport factor and hence the common base current gain (α) of a BJT.
6. Consider an ideal metal/semiconductor Schottky contact. If the work function of the metal is 3.8 eV and that of the semiconductor is 4 eV, is the semiconductor n-type or p-type? Give proper reasoning for the answer.
7. Draw the structural diagram, input and output characteristics of an n-channel enhancement type MOSFET.
8. Discuss the effect of channel length on the threshold voltage needed to cause inversion in Short-Channel MOSFETs. Give proper reasoning for the answer.
9. Give an example of transferred electron device and explain its operation.
10. Why is silicon not a preferred material for fabricating LEDs?

Part-B (5 X 10=50 Marks)

11. a) Discuss about different types of mechanisms that govern the transport of carriers in semiconductors. (5)

    b) The effective mass and the mobility of electrons in pure GaAs at 300 K are 0.067m_0 and 8500 cm^2/V.s respectively. Calculate the relaxation time. If this sample is doped at $N_d = 10^{17}$ cm^{-3}, the mobility decreases to 5000 cm^2/V.s, m_0 = 9.1 X 10^{-31}kg, e = 1.6 X 10^{-19}coulomb. Calculate the relaxation time due to ionized impurity scattering. (Note: relaxation time describes the mean time between successive collisions during the drift of electrons in solids) (5)

12. a) Explain the Ebers – Moll model for a bipolar junction transistor in detail. (5)

    b) Mention some limitations of Ebers – Moll model. Suggest an alternate model to account for these limitations. (5)

13. a) Derive an expression for the transconductance in saturation [$g_m(sat)$] of an ideal MESFET using the expression for saturation current given below.

$$I_D(sat) = g_0\left[\frac{V_p}{3} - V_{bi} + V_{GS} + \frac{2(V_{bi} - V_{GS})^{3/2}}{3V_p^{1/2}}\right]$$

(5)

b) Consider a GaAs MESFET with: Channel conductance (g_0) = 5mS, BuiltinvoltageV_{bi} = 0.76 V and Pinch off voltage V_p = 2.24 V. Calculate V_{DS} (sat.), I_D (sat.) and g_m(sat.) for V_{GS} = +0.64 V. (5)

14. a) Describe the structure and operation of a thin film transistor (TFT). How is it different from conventional transistors? Give some applications to TFTs. (6)

b) Describe the role of "silicon in SOIFET" and explain its operation. (4)

15. a) Explain the principle and operation of Oscillator based on negative resistance. (6)

b) Define injection efficiency (γ) for a light emitting diode (LED). Obtain an expression for γ in terms of all possible currents in a forward biased LED. What are the design considerations for attaining 100% efficiency? (4)

16. Write brief notes on:

a) Hall Effect and its applications (5)

b) Hetero Junctions and their applications. (5)

17. Write brief notes on *any two* of the following topics:

a) MIS Diode. (5)

b) Band-gap engineering. (5)

c) Hot electrons and their effects on device performance. (5)

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