Hall Ticket Number:

Code No. : 21604

VASAVI COLLEGE OF ENGINEERING *(Autonomous)*, HYDERABAD

M.E. (ECE: CBCS) I-Semester Main Examinations, January-2018

(Embedded Systems & VLSI Design)

Physics of Semiconductor Devices

Time: **3** hours Max. Marks: **60**

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

Part-A (10 × 2 = 20 Marks)

1. Suggest a suitable experiment to determine whether a given piece of material is a metal or semiconductor.
2. The mobility and effective mass of electrons in GaAs are 8500 $cm^2/V.s$ and $0.067m_0$ respectively. Calculate the diffusion coefficient for electrons in GaAs.
3. Draw schematics showing the model profiles of charge densities, electric field and potential in the depletion region of an unbiased p-n diode.
4. Define secondary breakdown in bipolar transistor.
5. Mention some advantages and disadvantages of FETs over BJTs.
6. Sketch model graphs showing the charge profiles and capacitance of a MOS capacitor as a function of applied voltage.
7. List different mechanisms that govern the gate leakage current in MOS devices.
8. Give some applications for Thin film transistors.
9. Write advantages of double hetero structure light emitting diodes.
10. Draw the band diagram of MIOS device for storing and erasing case.

Part-B (5 × 8 = 40 Marks)

11. a) Define Hall Effect and obtain an expression for Hall Coefficient. [5]

    b) Give continuity equation. Mention the significance of all of its terms. [3]

12. a) The built-in voltage (eV_{bi}) of an abrupt "p^+-n" junction is 0.834 eV. The Donor density $N_D = 1 \times 10^{16}$ cm^{-3}. The cross-sectional area (A) of this diode is 10 μm^2. Assume that all the Donors are ionized and calculate the amount of charge stored in the depletion layer of this diode (Hint: width on p-side is negligible). [5]

    b) Draw a schematic showing the structure of a BJT. Indicate various components of currents that flow through the transistor and give transistor equation. [3]

13. a) Write differences between rectifying and ohmic contact . [4]

    b) Describe the effect of interface and oxide traps on threshold voltage of MOSFET. [4]

14. a) Discuss about the effects of channel length on various properties of MOSFETs. List some important differences between long channel and short channel devices. [5]

    b) Consider an n-Channel GaAs MESFET with $V_{GS} = 0$. What will be the change in the effective channel length if the drain voltage is increased by 1 V from V_{DS}(Sat). [3]

15. a) Discuss about materials used in different applications of LED's. [3]

    b) Explain the operation of SAMOS device along with band diagrams [5]

Contd... 2

16. a) A piece of Si is doped such that the concentration of free electrons (n) is 4.5×10^{15} cm^{-3}. Estimate the concentration of holes (p) in this sample at 300 K. [3]

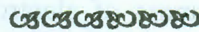
    b) State reasons for hetero junction bipolar transistors being suitable for high speed applications. [5]

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

    a) Buried Channeled Devices [4]

    b) Silicon on Insulator (SOI) Devices [4]

    c) Transferred Electron Devices. [4]



Useful Data:

$\varepsilon_r = 13.2$ (for GaAs) and $\varepsilon_r = 11.9$ (for Si) and $\varepsilon_0 = 8.854 \times 10^{-14}$ F/cm

MATERIAL	CONDUCTION BAND EFFECTIVE DENSITY (N_C)	VALENCE BAND EFFECTIVE DENSITY (N_V)	INTRINSIC CARRIER CONCENTRATION ($n_i = p_i$)
Si (300 K)	2.78×10^{19} cm^{-3}	9.84×10^{18} cm^{-3}	1.5×10^{10} cm^{-3}
Ge (300 K)	1.04×10^{19} cm^{-3}	6.0×10^{18} cm^{-3}	2.33×10^{13} cm^{-3}
GaAs (300 K)	4.45×10^{17} cm^{-3}	7.72×10^{18} cm^{-3}	1.84×10^{6} cm^{-3}