Hall Ticket Number:

Code No. : 6134

VASAVI COLLEGE OF ENGINEERING *(Autonomous)*, HYDERABAD

M.E. (ECE: CBCS) I-Semester Main Examinations, Jan./Feb.-2017

(Embedded Systems & VLSI Design)

Physics of Semiconductor Devices

Time: 3 hours Max. Marks: 70

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

Part-A (10 × 2 = 20 Marks)

1. List some important differences between metals, semiconductors and insulators.
2. What do you understand by "effective mass of carriers" in semiconductors?
3. Why a normal silicon diode cannot be used for microwave and high frequency applications? Give proper reasoning.
4. Draw model graph showing the output characteristics of a bipolar transistor. Indicate the region that is influenced by Early effect.
5. For an n–channel n^+–poly silicon –SiO_2 –Si MOSFET with $C_0 = 6.9 \times 10^{-7}$ F/cm^{-3} and $V_{FB} = -1.1$V. Calculate threshold voltage when $2\Psi_B = 084\ V, \varepsilon_s = 11.9 \times 8.85 \times 10^{-14}$.
6. Sketch a model graph showing the "Capacitance – Voltage (C-V)" characteristics of a MOS Diode. Identify different regions of operation.
7. What is sub threshold current in MOSFETs and what is its significance?
8. List some important differences between long channel and short channel devices.
9. Give examples of any two materials that are most suited for fabricating Transferred Electron Devices (TEDs).
10. Distinguish direct and indirect band gap materials with the help of energy band diagrams.

Part-B (5 × 10 = 50 Marks)

11. a) Define mobility and Diffusivity of carriers in Semiconductors. Derive the following relation between the diffusivity (D_n) and mobility (μ_n) of electrons in semiconductors. [6]

$$\frac{D_n}{\mu_n} = \frac{K_B T}{e}$$

b) The mobility and effective mass of electrons in GaAs are 8500 cm^2/V.s and $0.067m_0$ respectively. Calculate [4]

i) the relaxation time and

ii) Diffusivity of electrons in GaAs at 300 K.

12. a) Draw schematics showing *i)* the profiles of charge densities, electric field and potential in the depletion region of an unbiased p-n diode and *ii)* the depletion layer, profiles of minority carriers and components of currents in a forward biased p-n diode. [6]

b) Sketch the energy band diagram of a p–n diode under thermal equilibrium (under NO applied bias) and show that the built-in voltage (V_{bi}) is given by: [4]

$$V_{bi} = \frac{K_B T}{e} In\left(\frac{n_n}{n_p}\right)$$

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13. a) Draw the schematic diagram and explain the operation of an n-channel enhancement type MOSFET. [6]

    b) Consider a GaAs MESFET with gold Schottky barrier of barrier height 0.8 V. The n-channel doping is 10^{17} cm^{-3} and the channel thickness is 0.25μm. Calculate the pinch-off voltage and threshold voltage at 300 K (Note: $\varepsilon_r = 13.2$ and $N_C = 4.45 \times 10^{17}\ cm^{-3}$ for GaAs). [4]

14. a) Identify and Discuss about the effects of channel length on various properties of MOSFETs. [6]

    b) Discuss about "band-gap engineering" in detail. [4]

15. a) What is transferred electron effect? How it can lead to negative differential resistance (NDR)? What are the possible applications of NDR in electronic devices? [5]

    b) Describe the structure and operation of a LASER Diode. How is it different from a simple LED? [5]

16. a) Explain Hall Effect with the help of neat diagrams and necessary equations. Mention some important applications for Hall Effect. [5]

    b) Describe Ebers–Moll model for a bipolar junction transistor with the help of neat diagrams and necessary equations. [5]

17. Write short notes on any *two* of the following:
    a) Buried Channel Devices [5]
    b) Silicon on Insulator (SOI) Devices [5]
    c) Floating Gate Devices. [5]

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