Register No.: ..... Name: .....

SAINTGITS COLLEGE OF ENGINEERING (AUTONOMOUS)

(AFFILIATED TO APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY, THIRUVANANTHAPURAM)

THIRD SEMESTER B.TECH DEGREE EXAMINATION (S), FEBRUARY 2023
ELECTRONICS AND COMMUNICATION ENGINEERING
(2020 SCHEME)

Course Code : **20ECT201**

Course Name: **Solid State Devices**

Max. Marks : **100** **Duration: 3 Hours**

PART A

(Answer all questions. Each question carries 3 marks)

1. Distinguish between elemental and compound semiconductors with example.
2. Sketch the energy band diagram of the given semiconductors in equilibrium. i) Intrinsic, ii) n-type and iii) p-type
3. List the assumptions taken for the derivation of diode current equation.
4. Describe the significance of quasi fermi level.
5. Explain emitter injection efficiency and base transportation factor in a BJT.
6. Explain the Early effect mechanism in BJT.
7. Write the expression for drain current at linear region and saturation region for a MOSFET.
8. Define threshold voltage of a MOS capacitor.
9. Discuss channel length modulation in MOSFET.
10. Explain the principle of operation of FinFET.

PART B

(Answer one full question from each module, each question carries 14 marks)

MODULE I

11. a) Derive the equation for hole concentration in a semiconductor under thermal equilibrium. (8)

    b) Calculate the thermal equilibrium electron and hole concentration for a Si semiconductor with band gap 1.12 eV, Fermi level 0.25 eV below conduction band, $N_c=2.8\times10^{19}cm^{-3}$ and $N_v=1.04\times10^{19}\ cm^{-3}$. (6)

OR

12. a) A silicon sample doped with $2\times10^{16}\ cm^{-3}$ of Boron atoms. Determine,
        i) The equilibrium electron and hole concentrations
        ii) Position of fermi energy level in the band diagram.
    (7)

    Given $n_i = 1.5 \times 10^{10}cm^{-3}$ for Silicon at 300K.

    b) Explain Fermi Dirac distribution function and position of Fermi level in intrinsic and extrinsic semiconductors with diagram. (7)

MODULE II

13. a) Explain the variation of mobility with temperature and doping. (6)
    b) Derive the continuity equation under steady state conditions, assuming the semiconductor is long and no drift current is present. (8)

OR

14. a) Derive the steady state diffusion equation in semiconductors. (7)
    b) A potential of 100mV is applied across a semiconductor bar, and the resulting current is 1mA. A magnetic field of 10^{-4}Wb/cm^2 is applied perpendicular to the semiconductor bar. The hall voltage measured is -2mV. The dimensions of the bar are width = 0.01mm, length = 5mm and thickness = 10 x 10^{-6}m. find i) the type of the semiconductor bar. ii) the concentration and the mobility of majority carriers. (7)

MODULE III

15. a) Explain the behavior of a metal and an n-type semiconductor junction with the help of energy band diagrams. (7)
    b) Derive the expression for ideal diode equation. (7)

OR

16. a) Derive the equation for the contact potential of a PN junction under thermal equilibrium. (8)
    b) Determine the base transport factor and the emitter injection efficiency of a p-n-p transistor with parameters, I_{Ep} = 2mA, I_{En} = 0.01mA, I_{Cp}= 1.98mA and I_{Cn} = 0.001mA. (6)

MODULE IV

17. a) Sketch the energy band diagrams of an ideal MOS capacitor under i) equilibrium ii) depletion iii) inversion and iv) strong inversion conditions. (7)
    b) Derive the expression for drain current of a MOSFET in the two regions of operation. (7)

OR

18. a) A silicon n channel MOSFET has μn = 600cm^2/V s, C_{ox} = 1.2 x 10^{-7} F/cm^2, W = 50μm, L=10μm and V_{TH} = 0.8V. Calculate the drain current when i) V_{GS}=2V and V_{DS}=1V ii) V_{GS} = 3V and V_{DS}= 5V. (7)
    b) Explain the operation of an n-channel MOSFET with necessary diagrams also describe its characteristics. (7)

MODULE V

19. a) Explain the concepts of velocity saturation and hot carrier effects in (7)

a MOSFET

b) Explain DIBL and its effects in MOSFET (7)

OR

20. a) Explain the challenges in device scaling? (6)

b) Describe the structure and working of a FINFET with suitable diagrams. (8)

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