Register No.: …… Name: ……..

SAINTGITS COLLEGE OF ENGINEERING (AUTONOMOUS)

(AFFILIATED TO APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY, THIRUVANANTHAPURAM)

THIRD SEMESTER B.TECH DEGREE EXAMINATION (S), MAY 2022
ELECTRONICS AND COMMUNICATION ENGINEERING
(2020 SCHEME)

Course Code: **20ECT201**

Course Name: **Solid State Devices**

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

PART A

1. Explain Fermi Dirac Distribution function. Plot the Fermi Dirac Distribution function for an intrinsic semiconductor.
2. Distinguish between direct and indirect band gap semiconductors.
3. Explain the effect of temperature on mobility.
4. What is hall effect?
5. Define injection efficiency and transport factor of a BJT. How they are related to α and β.
6. Explain base width modulation with neat diagram.
7. Differentiate between Enhancement type and Depletion type MOSFET.
8. What is body effect?
9. Differentiate between constant voltage scaling and constant field scaling.
10. Illustrate hot carrier effects in MOSFET.

PART B

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

MODULE I

11. a) Derive mass action law. (8)
    b) A silicon sample is doped with 10^{17} As atoms/cm^3. What is the equilibrium hole concentration p_0 at 300K? Where is E_f relative to E_i? Take $n_i = 1.5 \times 10^{10}/cm^3$. (6)

OR

12. a) With the help of suitable schematics, derive the equilibrium concentration of electrons and holes in a semiconductor. (10)
    b) Compare direct bandgap and indirect bandgap semiconductors. (4)

MODULE II

13. a) Describe diffusion process. Derive the expression for diffusion current density. (8)
    b) A silicon bar 0.1cm long and 100 μm^2 in cross sectional area is doped with $10^{17}cm^{-3}$ phosphorus. Find the current at 300 K with 10 V applied. Given μ_n = 700 cm^2/V-s. (6)

OR

14. a) Derive the continuity equations for holes and electrons in a semiconductor. (7)
    b) Derive and explain Einstein relations. (7)

MODULE III

15. a) Derive the expression for ideal diode equation. State the assumption used. (9)
    b) Calculate the contact potential of a PN junction diode having $N_A = 2 \times 10^{16}/cm^3$ and $N_D = 5 \times 10^{13}/cm^3$ at T = 300K. Take $n_i = 1.5 \times 10^{10}/cm^3$ (5)

OR

16. a) Write notes on metal semiconductor contacts. (8)
    b) Draw the energy band diagram of a PN junction i) at equilibrium ii) under forward bias iii) under reverse bias. (6)

MODULE IV

17. a) With the help of necessary diagrams, explain equilibrium, accumulation, depletion and inversion stages of a MOS capacitor. (10)
    b) For an n-channel MOSFET with a gate oxide thickness of 10 nm, $V_T = 0.6V$, and Z = 25 μm, L = 1 μm. Calculate the drain current at $V_G = 5V$ and $V_D = 0.1V$. Assume an electron channel mobility of $\bar{\mu}_n = 200\ cm^2/V\text{-}s$. (4)

OR

18. a) Derive the expression for drain current at saturation for a MOSFET. (7)
    b) Describe the C-V characteristics of an ideal MOS capacitor. (7)

MODULE V

19. a) Explain Drain induced barrier lowering, Velocity Saturation and Threshold Voltage variations associated with scaling down of MOSFETs (9)
    b) Plot the sub threshold characteristics of MOSFET and explain. (5)

OR

20. Explain the structure and working of a FINFET with necessary diagrams. List its advantages. (14)

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