Reg. No.															

B.Tech. DEGREE EXAMINATION, DECEMBER 2023

Fourth Semester

18ECE203T – SEMICONDUCTOR DEVICE MODELING

(For the candidates admitted from the academic year 2020-2021 to 2021-2022)

Note:

(i) **Part - A** should be answered in OMR sheet within first 40 minutes and OMR sheet should be handed over to hall invigilator at the end of 40th minute.

(ii) **Part - B & Part - C** should be answered in answer booklet.

Time: 3 hours | Max. Marks: 100

PART – A (20 × 1 = 20 Marks)

Answer **ALL** Questions

	Marks	BL	CO	PO
1. Fermi distribution function at T =0K takes (A) Rectangular form (B) Square form (C) Circular form (D) Elliptical form	1	1	1	1
2. The meaning of non-radiative recombination is that the (A) Light is lost as heat (B) Light is lost as photon (C) Light is converted to current (D) Light is converted to voltage	1	2	1	1
3. An amorphous material is one in which the arrangement of atoms is (A) Random (B) Hexagonal (C) Crystalline (D) Periodic	1	1	1	1
4. III-V group elements are also called as (A) Compound semiconductors (B) Elemental semiconductors (C) Pure semiconductors (D) Impure semiconductors	1	1	1	1
5. Which statement is correct? (A) Diodes are non linear, two terminal, passive electrical devices (B) Diodes are linear, two terminal, passive electrical devices (C) Diodes are non linear, two terminal active electrical devices (D) Didoes are linear, two terminal, active electrical devices	1	1	2	1
6. In a silicon PN junction diode, the reverse current is due to _____and _____and the reverse saturation current nearly doubles for _____rise in temperature. (A) Thermal generation and drift, 5° (B) Thermal generation and diffusion, 5° (C) Thermal generation and diffusion, 10° (D) Thermal generation and drift, 10°	1	2	2	2

7. Under equilibrium condition 1 1 2 1
   (A) Only holes will flow (B) Only electrons will flow
   (C) Both electrons and holes will flow (D) None will flow

8. In an abrupt junction diode, the doping on either side is 1 1 2 1
   (A) Constant (B) Varies linearly
   (C) Varies as square (D) Varies square root

9. In a transistor if $\beta = 100$ and collector current is 10 mA, then I_E is 1 2 3 2
   (A) 10 mA (B) 10.1 mA
   (C) 1.1 mA (D) 1.2 mA

10. For a BJT, the effective current gain is decided by the 1 2 3 1
   (A) Component 1: injection of holes from B to E (B) Component 2: injection of electrons from B to E
   (C) Component 1: injection of holes from C to B (D) Component 2: injection of holes from B to E

11. Which statement is true for high level injection in a BJT at high bias? 1 2 3 2
   (A) The electrons injected from E to B becomes comparable to the holes in B (B) The holes injected from B to E becomes comparable to the holes in E
   (C) The electrons injected from E to B becomes comparable to the electrons in B (D) The holes injected from B to E becomes comparable to the holes in B

12. Which statement among the following is true for a BJT? 1 2 3 2
   (A) Forward biasing be junction give rise to depletion charge and thus junction capacitance (B) Forward biasing be junction give rise to diffusion charge and thus junction capacitance
   (C) Forward biasing be junction give rise to depletion charge and thus diffusion capacitance (D) Forward biasing be junction give rise to diffusion charge and thus diffusion capacitance

13. The typical high frequency MOS capacitance is less than the low frequency capacitance in which region(s) of operation? 1 3 4 1
   (A) Accumulation (B) Depletion
   (C) Inversion (D) Accumulation and depletion

14. Choose the correct statement among the followings 1 3 4 1
   (A) MOSFET is a unipolar, voltage controlled, two terminal device (B) MOSFET is a bipolar, current controlled, three terminals device
   (C) MOSFET is a unipolar, voltage controlled, three terminal device (D) MOSFET is a bipolar current controlled, two terminal device

15. The transit time of the current carriers through the channel of an FET decides its 1 2 4 1
   (A) Switching characteristics (B) Forward characteristics
   (C) Output characteristics (D) Reverse characteristics

16. If the fixed positive charges are present at the gate oxide of an N channel enhancement type MOSFET, it will lead to — 1 3 4 1

(A) A decrease in the threshold voltage
(B) Channel length modulation
(C) Increase in substrate leakage current
(D) Increase in an accumulation capacitance

17. Punch through is a process in which — 1 1 5 1

(A) Depletion region of source and drain merge together
(B) Doping of source and drain is same
(C) Potential of source and drain is same
(D) Field at source and drain is same

18. Velocity saturation in MOSFET occurs for — 1 1 5 1

(A) Low electric field
(B) High electric field
(C) High doping
(D) Low doping

19. Hot carrier effect in MOSFET results in — 1 1 5 1

(A) Gate oxide leakage
(B) Drain leakage
(C) Source leakage
(D) Bulk leakage

20. For proper operation of the MOSFET, the body potential should be kept same as — 1 2 5 4

(A) Source potential
(B) Drain potential
(C) Gate potential
(D) Channel potential

PART – B (5 × 4 = 20 Marks)

Answer **ANY FIVE** Questions

	Marks	BL	CO	PO
21. Explain in brief the various recombination mechanism in a semiconductor using energy band diagram.	4	2	1	2
22. A P^+ junction has $N_a = 10^{20} cm^{-3}$ and $N_d = 10^{17} cm^{-3}$, What is i. its built in potential, ii. W, iii. X_n and iv. X_P? Assume $n_i = 10^{10}$ at T = 300K	4	3	2	2
23. Explain in detail the current components of a NPNBJT.	4	2	3	2
24. Discuss in brief the oxide charges in a MOSFET with suitable diagrams.	4	3	4	1
25. Draw the small signal model for a MOSFET and write the expression for its small signal components.	4	3	5	1
26. Explain Figure of Merit for a MOSFET in brief.	4	2	4	1
27. Describe the various capacitances in a PN junction diode with suitable diagram and equations.	4	2	2	1

PART – C (5 × 12 = 60 Marks)

Answer **ALL** Questions

		Marks	BL	CO	PO
28. a.	Derive the expression for holes in the valence band assuming Boltzmann's approximation.	12	3	1	2
	(OR)				
b.	Determine the intrinsic carrier concentration in GaAs at T = 300K and at T = 450K the N_C and N_V are 4.7×10^{17} cm^{-3} and 7.0×10^{18} cm^{-3} respectively at 300K. Eg for GaAs is 1.42eV.	12	3	1	2
29. a.	Design a silicon PN junction diode at T = 300K such that J_n = 20 A/cm^2 and J_P = 5 A/cm^2 at V_F = 0.65V. Assume $n_i = 1.5 \times 10^{10}$ cm^{-3}, D_n = 25 cm^2/s $D_p = 10cm^2/s$, $t_{po} = t_{no} = 5 \times 10^{-7}s$, $e_1 = 11.7$	12	3	2	2
	(OR)				
b.	Derive the expression for the width of the space charge layer for linearly graded junction at zero bias.	12	3	2	2
30. a.	Explain the working of a NPN Bipolar junction transistor with suitable diagram and expressions.	12	2	3	1
	(OR)				
b.	Derive the EBERS-MOLL model of BJT using suitable expressions and figures.	12	2	3	1
31. a.	Explain the low and high frequency capacitance – voltage characteristics of a MOS diode and highlight the different regions clearly.	12	2	4	1
	(OR)				
b.	For a MOS capacitor in strong inversion mode, derive the equation of inversion charge.	12	2	4	1
32. a.	Discuss the electric field effect (lateral and vertical) on the MOS characteristics with suitable diagrams and expressions.	12	3	5	1
	(OR)				
b.	Explain the following short channel effects of MOSFET in brief with suitable diagrams i. Mobility Degradation ii. Channel length Modulation iii. Subthreshold Conduction iv. Body Effect.	12	3	5	1

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