24.	Discuss the flat band condition in a MOS diode with energy band diagram and find the expression for flat band voltage.	4	3	4	1
25.	Write short notes on SOI MOSFET with the help of neat and labelled diagram.	4	2	5	1
26.	Determine the probability that an energy level in the conduction band is occupied by an Electron at T = 300K. Assume Fermi energy is 0.25eV below conduction band (E_c).	4	3	1	2
27.	Draw and compare the electric field and potential profile within space charge region in a diode at Equilibrium, forward biased and reverse biased conditions.	4	2	2	2

PART – C (5 × 12 = 60 Marks)

Answer **ALL** Questions

		Marks	BL	CO	PO
28. a.	A Bar of silicon is doped with Boron at $10^{15}cm^{-3}$. It is exposed to light such that electron hole pairs are generated. Throughout the volume of the bar at the rate of $10^{20}/s.cm^3$. The recombination life time is 10μs. Determine: (i) P_o (ii) η_o (iii) Δ_p (iv) Δ_n (v) P_{net} and (vi) η_{net}	12	3	1	2
	(OR)				
b.	Derive the expression for Fermi level for an intrinsic semiconductor and comment on the result obtained.	12	3	1	2
29. a.	Derive the current voltage relation in a PN junction diode with abrupt Junction.	12	3	2	2
	(OR)				
b.	Derive the expression for the width of the space charge region for abrupt junction at zero bias in terms of potential barrier.	12	3	2	2
30. a.	Derive the EBERS-MOLL model for BJT using suitable expressions and figures.	12	2	3	2
	(OR)				
b.	Using EBERS-MOLL mode, derive the current gain for common base and common emitter configuration using suitable diagram.	12	3	3	2
31. a.	For MOS capacitor in strong inversion mode, derive the equation of inversion charge.	12	2	4	1
	(OR)				
b.	Derive the expression for the drain current for a N-channel MOSFET. State the assumptions made.	12	3	4	1
32. a.	Explain the following short channel effects of MOSFET in brief with suitable diagrams. i. Drain induced barrier lowering ii. Punch through iii. Hot Electron Effect iv. Velocity Saturation.	12	3	5	1
	(OR)				
b.	Discuss different types of scaling in a MOSFET in detail.	12	2	5	1

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Reg. No.														

B.Tech. DEGREE EXAMINATION, MAY 2023

Fourth Semester

18ECE203T – SEMICONDUCTOR DEVICE MODELING

(For the candidates admitted from the academic year 2018-2019 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.	If an intrinsic semiconductor is doped with equal amount of donor and acceptor atoms, the material is (A) N-type (B) P-type (C) Compensated (D) Ionized	1	1	1	1
2.	The phenomenon opposite to complete ionization is called as (A) Freeze out (B) Incomplete ionization (C) Bonding (D) Neutralized	1	2	1	1
3.	A typical scattering time of a charge particle is in the range of (A) Pico second (B) Nano second (C) Micro second (D) Milli second	1	1	1	2
4.	The conductivity of silicon in intrinsic condition at a room temperature of 300 K for n_i for silicon at 300 K is $1.45\times10^{10}cm^{-3}$, $\mu_n = 1200cm^2/V_s$, $\mu_p = 600cm^2/Vs$. (A) $4.10\times10^{-6}/ohm-cm$ (B) $5.10\times10^{-6}/ohm-cm$ (C) $6.10\times10^{-6}/ohm-cm$ (D) $7.10\times10^{-6}/ohm-cm$	1	2	1	2
5.	In the depletion region of a p-n junction, there is a shortage of (A) Acceptor ions (B) Holes and electrons (C) Donor ions (D) Holes only	1	1	2	1
6.	For an ideal diode model, constant diode model and the model with resistance, the diode can be treated as in the forward biased condition (A) Short circuit, equivalent voltage and equivalent voltage with resistance (B) Open circuit, equivalent voltage and equivalent voltage with resistance (C) Open circuit, equivalent current and equivalent voltage with resistance (D) Short circuit, equivalent current and equivalent voltage with resistance	1	1	2	1

7. A p-n junction diode allows current flow when — 1 2 2 1

(A) The P-type material is more positive than the n-type material
(B) The N-type material is more positive that the P-type material
(C) Both the n-type and p-type materials have the same potential
(D) There is no potential on the N-type or P-type materials

8. The maximum electric field is at — 1 1 2 1

(A) At the centre of the p-n junction
(B) Towards p side
(C) Towards n side
(D) At the centre of depletion region

9. The central feature of a transistor states — 1 2 3 1

(A) Output current is a function of output voltage
(B) Output current is a function of input voltage
(C) Output voltage is a function of input current
(D) Output voltage is a function of output current

10. The BJT is a — 1 2 3 1

(A) Symmetric device with emitter and collector non interchangeable
(B) Unsymmetrical device with emitter and collector non-interchangeable
(C) Symmetric device with emitter and collector interchangeable
(D) Unsymmetrical device with emitter and collector interchangeable

11. The emitter injection efficiency (EIE) for a BJT can be expressed as _____and for a $\beta = 800$, EIE has the value of _____ — 1 2 3 2

(A) Emitter is more efficient in terms of injecting electrons rather than B injecting holes, 0.99
(B) Emitter is more efficient in terms of accepting electrons rather than B injecting holes, 0.99
(C) Emitter is more efficient in terms of injecting minority charges rather than B injecting holes, 0.96
(D) Emitter is more efficient in terms of injecting holes rather than B injecting electrons, 0.96

12. For a BJT to work as an amplifier — 1 1 3 1

(A) E-B junction is forward biased and B-E junction is reversed biased
(B) E-B junction is reverse biased and B-C junction is forward biased
(C) E-B junction is forward biased and B-C junction is also forward biased
(D) The collector-emitter voltage has to be larger than 0.2 V

13. Which layer is sandwiched in MOS diode? — 1 1 4 1

(A) Metal
(B) Semiconductor
(C) Insulator
(D) Polysilicon

14. The output characteristics of a MOSFET, is a plot of — 1 1 4 1

(A) I_{ds} as a function of V_{GS} with V_{ds} as a parameter
(B) I_{ds} as a function of V_{ds} with V_{GS} as a parameter
(C) I_{gs} as a function of V_{gs} with V_{ds} as a parameter
(D) I_{gs} as a function of V_{ds} with V_{gs} as a parameter

15. The value of thermal voltage at room temperature is — 1 1 4 1

(A) 52 mV
(B) 127 mV
(C) 0.5 V
(D) 0.026 V

16. If the gate is biased above threshold means — 1 2 4 1

(A) The surface is inverted
(B) Channel is not formed
(C) Depletion layer does not form
(D) Electrons is flowing from drain to source

17. According to Moore's law, after every _____months, the number of chips will get _____ — 1 1 5 1

(A) 18, doubled
(B) 12 months, doubled
(C) 24 months, 1.5 times
(D) 12 months, 1.5 times

18. Due to Channel Length Modulation (CLM) — 1 1 5 1

(A) The drain current increases
(B) The drain current decreases
(C) Effective channel length increases
(D) Effective channel width increases

19. As the gate oxide gets thinner — 1 2 5 1

(A) The transverse electric field component decreases
(B) The transverse electric field component increases
(C) The transverse electric field component remains same
(D) None of the above

20. MOSFETs are intentionally strained — 1 2 5 1

(A) To reduce threshold voltage variations
(B) To lower the surface state density
(C) To decrease series resistance
(D) To increase the channel mobility and therefore, drain current

PART – B (5 × 4 = 20 Marks)

Answer **ANY FIVE** Questions

	Marks	BL	CO	PO
21. Derive the expression for the carrier concentration in intrinsic semiconductors at equilibrium.	4	2	1	2
22. Calculate the built-in potential at 300K for an abrupt silicon P-n junction with $N_A = 10^{23}$ per cm^3 and $N_D = 10^{20}$ per cm^3 on the P side and N side respectively.	4	3	2	2
23. Draw a EBERS MOLL model for a BJT and explain all its component in brief.	4	3	3	2