Reg. No.															

B.Tech. DEGREE EXAMINATION, MAY 2024

Fourth Semester

18ECE321T – RF AND MICROWAVE SEMICONDUCTOR DEVICES

(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. The capacitance of a reverse biased PN junction (A) Decreases as reverse bias is increased (B) Increases as reverse bias is increased (C) Increases as reverse bias is decreased (D) Is significantly low	1	1	1	1
2. PN junction failure below 5V is caused primarily by (A) Zener breakdown (B) Saturation (C) Avalanche breakdown (D) Either avalanche breakdown or Zener breakdown	1	1	1	1
3. Schottky diode has junction made up of (A) Metal to n-region (B) P to n region (C) Metal to insulator (D) Metal to semiconductor	1	1	1	1
4. At microwave frequencies, the varactor is not useful for (A) Frequency multiplication (B) Electronic tuning (C) Oscillators (D) Amplifiers	1	1	1	1
5. The number of semiconductor layers in a TRAPATT diode is (A) 4 (B) 1 (C) 2 (D) 3	1	1	2	1
6. Tunnel diode is best suited for (A) Oscillators (B) Amplifiers (C) Rectifiers (D) Amplitude limiters	1	1	2	1
7. The most commonly used material for gunn diodes is (A) GaAs (B) Si (C) Ge (D) Se	1	1	2	1
8. The resonant frequency of an IMPATT diode is given by (A) $V_d/2L$ (B) V_d/L (C) $V_d/4\pi L$ (D) $V_d/2\pi L$	1	1	2	1

9. BJT is a _____ driven device. 1 1 3 1

(A) Voltage (B) Current
(C) Gain (D) Power

10. Advantage of HJT over BJT is that it has 1 1 3 1

(A) Sophisticated construction (B) Low frequency of operation
(C) Higher gain (D) High frequency of operation

11. In MESFET, _____ is used for gate. 1 1 3 1

(A) pnp junction (B) n junction
(C) npn junction (D) Schottky junction

12. If gate-metal layer is in contact with the implant layer _____ is formed. 1 1 3 1

(A) Buffer (B) Switch
(C) Transistor (D) Diode

13. Critical or breakdown field of a high power transistor determines the _____ of a transistor. 1 1 4 1

(A) Highest operating voltage (B) Lowest operating current
(C) Highest operating current (D) Lowest operating voltage

14. The power added efficiency of the RF power transistor quantifies the amount of 1 1 4 1

(A) DC bias that is converted to IF power (B) AC bias that is converted to RF power
(C) AC bias that is converted to IF power (D) DC bias that is converted to RF power

15. The crucial parameter in the design of the gate drain depletion region in HEMT is 1 1 4 1

(A) The gate-drain separation L_{gd} (B) The source-drain separation L_{sd}
(C) The gate-drain voltage V_{gd} (D) The gate-source separation L_{gs}

16. The drain delay in HEMT is the time required by the electron to traverse the depletion region between 1 1 4 1

(A) The gate and the drain (B) The source and the drain
(C) The gate and the source (D) The source voltage and the drain voltage

17. To begin the package design, the first concern is having a through and in-depth knowledge of the 1 1 5 1

(A) Component (B) Module
(C) Applications (D) Substrate

18. It is common for the RF power chains within base station circuits to dissipate 100 to _____ watts each. 1 1 5 1

(A) 150 (B) 200
(C) 400 (D) 300

19. Verification testing of the prototypes may include _____ scanning to assess thermal transfer. 1 1 5 1

(A) Wired (B) BT
(C) OR (D) IR

20.	In component packages that provide for lateral spreading of the heat generated in the devices, the increasing cross sectional area for heat flow at successive "Layers" adjacent to the device. (A) Removes the internal thermal resistance (B) Increases the internal thermal resistance (C) Adds the internal thermal resistance (D) Reduces the internal thermal resistance	1	1	5	1

PART – B (5 × 4 = 20 Marks)
Answer **ANY FIVE** Questions

		Marks	BL	CO	PO
21.	Mention the applications of PIN diode.	4	2	1	1
22.	Express the conduction band and valance band differentials of heterojunctions.	4	2	1	1
23.	An IMPATT diode has the following parameters Carrier drift velocity $V_d = 2\times10^7 cm/s$ Drift region length L = 6 μm Maximum operating voltage $V_{0\max} = 100V$ Maximum operating current $I_{0\max} = 200mA$ Efficiency η=15% Breakdown voltage $V_{bd} = 90V$ Compute the resonant frequency.	4	3	2	4
24.	List out the operation modes of gunn diode.	4	2	2	1
25.	Determine the maximum oscillation frequency of MESFET.	4	2	3	1
26.	Examine the scaling issues in HEMT transistors.	4	2	4	1
27.	Explore the thermal resistance in RF package with relevant expressions.	4	2	5	1

PART – C (5 × 12 = 60 Marks)
Answer **ALL** Questions

		Marks	BL	CO	PO
28. a.	Investigate the operation of hot carrier diode with neat sketch and mention the applications.	12	4	1	1
	(OR)				
b.i.	Illustrate the operational mechanism for an isolated n-Ge and P-GaAs hetero junction transistor.	6	4	1	1
ii.	A Ge-GaAs heterojunction transistor has the following parameters Lattice constant: Ge, $a_1 = 5.646\mathring{A}$ GaAs, $a_2 = 5.653\mathring{A}$ Electron affinity: G_e, $X_1 = 4.0eV$ $GaAs\ X_2 = 4.07eV$ Energy gap $Ge, E_{g1} = 0.80eV$ $GaAs, E_{g2} = 1.43eV$	6	3	1	4

Determine the lattice match in percent, the conduction and valance band differentials between Ge and GaAs.

29. a.	Examine the voltage and current waveforms for TRAPATT diode with the physical structure and determine the transit time of the carriers.	12	3	2	1
	(OR)				
b.	Describe the operational principle of microwave tunnel diode with V-I characteristics.	12	4	2	1
30. a.	Interpret the small signal equivalent circuit of a MESFET and deduce drain current and transconductance.	12	3	3	1
	(OR)				
b.	A typical n-channel GaAs MESFET has the following parameters. Electron concentration, $N_d = 8 \times 10^{17} cm^{-3}$ Channel height a = 0.1 μm Relative dielectric constant $\varepsilon_r = 13.1$ Channel length L = 14 μm Channel width Z=36 μm Electron mobility μ=0.08 m^2/Vs Drain voltage $V_d = 5V$ Gate voltage $V_g = -2v$ Saturation drift velocity $v_s = 2 \times 10^5 m/s$. Calculate the pinch-off voltage, velocity ratio and the saturation current at $V_g = 0$.	12	3	3	4
31. a.	Investigate the operational mechanism of HEMT with the cross sectional structure and calculate drain current from V-I characteristics.	12	4	4	1
	(OR)				
b.	A HEMT has the following parameters Threshold voltage $V_{th} = 0.13V$ Donor concentration $N_d = 2 \times 10^{24} m^{-3}$ Metal semiconductor Schottky barrier potential $\psi_{ms} = 0.8V$ GaAs bandgap E_{gg} =1.43 V AlGaAs bandgap E_{ga} =1.8 V AlGaAs dielectric constant $\varepsilon_r = 4.43$ Compute the conduction band edge difference between GaAs and AlGaAs and the sensitivity of HEMT.	12	3	4	4
32. a.	Investigate the technique used to measure the fracture strength of semiconductor die.	12	4	5	1
	(OR)				
b.	Evaluate the temperature differences encountered in the flow of heat within electronic systems.	12	3	5	4

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