

- ii. Calculate the avalanche-zone velocity of a TRAPATT diode with the doping concentration of  $2 \times 10^{15} \text{ cm}^{-3}$  and current density of  $20 \text{ kA/cm}^2$ . 4 3 2 1,4
28. a. Illustrate the working principle of GaAs MESFET with schematic diagram and circuit symbol. Also express pinch-off voltage. 10 4 3 1,4
- (OR)**
- b.i. With relevant expression, describe the pinch-off voltage of a microwave field effect transistor. 5 3 3 1,4
- ii. Calculate the pinch-off voltage of a certain Si JFET, with the channel height of  $0.1 \text{ } \mu\text{m}$ , electron concentration of  $8 \times 10^{17} \text{ cm}^{-3}$  and relative dielectric constant of 11.8. 5 3 3 1,4
29. a. Explore the structure of HEMT and the processing steps for HEMT direct coupled FET logic circuits with operational mechanism. 10 4 4 1,4
- (OR)**
- b.i. Examine the performance characteristics of HEMT and draw the equivalent circuit. 5 3 4 1,4
- ii. Compute the conduction band-edge difference between GaAs and AlGaAs and the sensitivity of HEMT for the threshold voltage of  $0.13 \text{ V}$ , donor concentration of  $2 \times 10^{24} \text{ m}^{-3}$ , metal semiconductor schottky barrier potential of  $0.8 \text{ V}$ , GaAs band gap of  $1.43 \text{ V}$ , AlGaAs bandgap of  $1.8 \text{ V}$  and AlGaAs dielectric constant of 4.43. 5 3 4 1,4
30. a. Construct the systematic methodology of successful RF and microwave package design and demonstrate. 10 4 5 1,3
- (OR)**
- b. Interpret the thermal analysis of resistance networks in electronic systems. 10 4 5 1,3

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**B.Tech. DEGREE EXAMINATION, NOVEMBER 2022**  
Sixth and Seventh Semester

18ECE321T – RF AND MICROWAVE SEMICONDUCTOR DEVICES  
(For the candidates admitted from the academic year 2018-2019 to 2019-2020)

**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 40<sup>th</sup> minute.
- (ii) **Part - B** should be answered in answer booklet.

Time: 2½ Hours

Max. Marks: 75

**PART – A (25 × 1 = 25 Marks)**

Answer ALL Questions

- |  | Marks | BL | CO | PO  |
|--|-------|----|----|-----|
| 1. The capacitance of a reverse biased PN junction<br>(A) Decreases as reverse bias is increased<br>(B) Increases as reverse bias is decreased<br>(C) Increases as reverse bias is increased<br>(D) Is significantly low | 1     | 1  | 1  | 1,4 |
| 2. The main material used in the construction of PIN diodes is<br>(A) Si<br>(B) GaAs<br>(C) Ge<br>(D) Se   | 1     | 1  | 1  | 1,4 |
| 3. PN junction failure below 5V is caused primarily by<br>(A) Avalanche breakdown<br>(B) Saturation<br>(C) Either (A) or (B)<br>(D) Zener breakdown  | 1     | 2  | 1  | 1,4 |
| 4. Schottky diode operates only with<br>(A) Capacitor<br>(B) Minority carries<br>(C) Majority carriers<br>(D) Inductor   | 1     | 1  | 1  | 1,4 |
| 5. Varactor diodes are used in FM receivers to obtain<br>(A) Automatic frequency control<br>(B) Automatic volume control<br>(C) Automatic gain control<br>(D) Automatic noise control                                    | 1     | 2  | 1  | 1,4 |
| 6. The tunnel diode is best suited for<br>(A) Oscillators<br>(B) Rectifiers<br>(C) Amplifiers<br>(D) Amplitude limiters  | 1     | 1  | 2  | 1,4 |
| 7. The gunn diode has<br>(A) Three PN junction<br>(B) A single PN junction<br>(C) No PN junction<br>(D) Two PN junction  | 1     | 1  | 2  | 1,4 |
| 8. Power diodes are used in<br>(A) Mixer<br>(B) Rectifiers<br>(C) Amplifier<br>(D) Oscillator  | 1     | 1  | 2  | 1,4 |

9. The number of semiconductor layers in IMPATT diode is  
(A) 2 (B) 3  
(C) 5 (D) 4
10. A major disadvantage of TRAPATT diode is  
(A) High noise figure (B) Fabrication is costly  
(C) Low gain (D) Low operational bandwidth
11. BJT is a \_\_\_\_\_ driven device.  
(A) Voltage (B) Power  
(C) Current (D) Gain
12. The frequency of operation of an FET is limited by  
(A) Gate to source voltage (B) Gate length  
(C) Drain to source voltage (D) Drain voltage
13. If gate-metal layer is in contact with the implant layer, \_\_\_\_\_ is formed.  
(A) Transistor (B) Buffer  
(C) Diode (D) Switch
14. The MESFET has maximum  
(A) Gate to drain voltage (B) Source voltage  
(C) Drain voltage (D) Gate to source voltage
15. The current gain of a BJT \_\_\_\_\_ with frequency.  
(A) Remains constant (B) Decreases  
(C) Increases (D) Zero
16. HEMT used in the microwave circuit is a  
(A) Detector (B) Low noise amplifier  
(C) High power amplifiers (D) Source
17. The method used for fabrication of GaAs FET is  
(A) Deposition (B) Diffusion  
(C) Conduction (D) Ion implantation
18. The power added efficiency of the RF power transistor quantities the amount of  
(A) AC bias that is converted to RF power (B) DC bias that is converted to IF power  
(C) DC bias that is converted to RF power (D) AC bias that is converted to IF power
19. The channel charging delay in HEMT is  
(A) Minimum at high current densities (B) Maximum at low current densities  
(C) Minimum at low current densities (D) Maximum at high current densities

20. The optimum value of  $L_{gd}$  in HEMT is  
(A) 3.2 times that of the gate length  $L_g$  (B) 2.3 times that of the gate length  $L_g$   
(C) 4.2 times that of the gate length  $L_g$  (D) 2.4 times that of the gate length  $L_g$
21. \_\_\_\_\_ management is probably one of the most critical aspects of the package design.  
(A) Mechanical (B) Electrical  
(C) Computer integrated (D) Thermal
22. The thermal conductivity of diamond is  
(A)  $41.6W / in^{\circ}C$  (B)  $40W / in^{\circ}C$   
(C)  $40.6W / in^{\circ}C$  (D)  $40.06W / in^{\circ}C$
23. \_\_\_\_\_ effects result in poor RF performance with respect to things such as gain, efficiency and intermodulation distortion etc.  
(A) Capacitive (B) Inductive  
(C) Resistive (D) Reactive
24. It is common for the RF power chains within base station circuits to dissipate 100 to \_\_\_\_\_ watts each.  
(A) 150 (B) 400  
(C) 300 (D) 200
25. The most critical heat-producing component for most RF systems is the \_\_\_\_\_ stage.  
(A) Frequency amplifier (B) Current amplifier  
(C) Voltage amplifier (D) Power amplifier

### PART – B (5 × 10 = 50 Marks)

Answer ALL Questions

26. a. Construct a schottky diode and illustrate the V-I characteristics of it. Also mention the advantages and applications. 10 4 1 1,4
- (OR)
- b. With neat sketch, develop a PIN diode and explain the working principle and characteristics. 10 4 1 1,4
27. a. Investigate the principles of operation of microwave tunnel diode with energy band diagrams and V-I characteristics. 10 4 2 1,4
- (OR)
- b.i. Compute the maximum CW output power and the resonant frequency of an IMPATT diode with the following parameters, carrier drift velocity of  $2 \times 10^7 cm / s$ , drift region length of 6  $\mu m$ , maximum operating voltage of 100 V, maximum operating current of 200 mA, efficiency of 15% and the break down voltage of 90 V. 6 3 2 1,4