B.Tech. DEGREE EXAMINATION, JUNE 2023

Third Semester

18ECC211J - SOLID STATE SEMICONDUCTOR DEVICES

(For the candidates admitted during 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 40 minutes.

ii. **Part - B** and **Part - C** should be answered in answer booklet.

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

	Part - A (20 × 1 Marks = 20 Marks) Answer **All** Questions	Marks	BL	CO
1.	What are the charge carriers in semiconductors? (A) Electrons and holes　(B) Electrons (C) Holes　(D) Charges	1	1	1
2.	How are charge carriers produced in intrinsic semiconductors? (A) By pure atoms　(B) By electrons (C) By impurity atoms　(D) By holes	1	1	1
3.	The most commonly used semiconductor is (A) Germanium　(B) Silicon (C) Carbon　(D) Sulphur.	1	1	1
4.	A semiconductor has generally _____ valence electrons. (A) 2　(B) 3 (C) 6　(D) 4	1	1	1
5.	Which diode employs graded doping? (A) Zener　(B) LED (C) Tunnel　(D) Step Recovery	1	2	2
6.	The device to use for rectifying a weak AC signal is a (A) Zener diode　(B) Light-emitting diode (C) Varactor　(D) Back diode	1	2	2
7.	Which of the following diodes does not oscillate due to negative-resistance characteristics? (A) Tunnel Diode　(B) SCR Diode (C) IMPATT Diode　(D) Gunn Diode	1	2	2
8.	Which diode is used in seven-segment displays? (A) Zener　(B) LED (C) Laser　(D) Schottky	1	1	2
9.	Which of the following is not a part of a BJT? (A) Base　(B) Collector (C) Emitter　(D) Drain	1	1	3
10.	If a BJT is to be used as an amplifier, then it must operate in (A) Cut-off mode　(B) Forward Active mode (C) Saturation mode　(D) Linear mode	1	1	3
11.	Which of the following is not a valid type of a BJT? (A) PNP　(B) NPN (C) PPN　(D) NNP	1	2	3

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32. a. An AC supply of 230 V is applied to a half-wave rectifier circuit through a transformer of turns ratio 5:1. Assume the diode is an ideal one. The load resistance is 300 W. Find (i) DC output voltage, (ii) PIV, (iii) maximum, and (iv) average values of power delivered to the load. **12　3　5**

(OR)

b. Explain the operation of the bridge rectifier in detail with a circuit diagram showing input and output waveform and list the advantages and disadvantages of the circuit.

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12. In a BJT, which of the following layers is heavily doped?   1   2   3
   - (A) Collector
   - (B) Emitter
   - (C) Base
   - (D) Gate

13. The arrow on the symbol of MOSFET indicates   1   2   4
   - (A) That it is an MOS diode
   - (B) The direction of electrons
   - (C) The direction of conventional current flow
   - (D) That it is a P-channel MOSFET

14. The controlling parameter in MOSFET is   1   2   4
   - (A) V_{DS}
   - (B) I_G
   - (C) V_{GS}
   - (D) I_S

15. A MOSFET uses the electric field of a _____ to control the channel current   1   2   4
   - (A) Capacitor
   - (B) Battery
   - (C) Generator
   - (D) Inductor

16. The effective channel length of a MOSFET in saturation decreases with increase in   1   2   4
   - (A) Gate voltage
   - (B) Drain voltage
   - (C) Source voltage
   - (D) Body voltage

17. A silicon diode in a half-wave rectifier has a barrier potential of 0.7 V. This has the effect of   1   1   5
   - (A) Reducing the peak output voltage by 0.7 V.
   - (B) Increasing the peak output voltage by 0.7 V.
   - (C) Reducing the peak input voltage by 0.7 V.
   - (D) Increasing the peak input voltage by 0.7 V.

18. In a full wave rectifier, if the input frequency is 50 Hz, then output frequency will be   1   2   5
   - (A) 50 Hz
   - (B) 75 Hz
   - (C) 100 Hz
   - (D) 200 Hz

19. For a rectifier circuit, if the peak height and the bottom height for a filtered output waveform is 11.923 V and 9.977 V respectively, the ripple voltage is given by   1   3   5
   - (A) 1.95
   - (B) 2.95
   - (C) 3.95
   - (D) 4.95

20. The percentage rectification efficiency for a half wave, center tap and bridge rectifier is   1   3   5
   - (A) 40.6, 81.2 and 81.2 respectively
   - (B) 40.6, 40.6 and 81.2 respectively
   - (C) 40.6, 81.2 and 40.6 respectively
   - (D) 81.2, 40.6 and 81.2 respectively

Part - B (5 × 4 Marks = 20 Marks)
Answer **any 5** Questions   Marks BL   CO

21. Explain the formation of the energy band diagram of a PN junction diode with proper labeling.   4   3   1

22. Explain the operation of the IMPATT diode with a suitable diagram.   4   1   2

23. Draw the hybrid Pi model equivalent circuits for Common Emitter (CE) and Common Base (CB) configurations.   4   2   3

24. With a neat diagram, explain the operation of N channel E-MOSFET   4   1   4

25. Draw the circuit diagram of a half-wave rectifier (with capacitor) and explain its operation with proper input and output waveform.   4   2   5

26. Explain Drift and Diffusion currents with reference to a semiconductor.   4   1   1

27. Explain the types of capacitance that are important for forward and reverse bias modes of operation for a PN junction diode.   4   3   2

Part - C (5 × 12 Marks = 60 Marks)
Answer **All** Questions   Marks BL   CO

28. a. Derive the expression for depletion width (W) for a uniformly doped PN junction diode.   12   3   1

   (OR)

   b. Find the resistivity of (a) intrinsic silicon and (b) p-type silicon with $N_A = 10^{16}/cm^3$. Use $n_i = 1.5 \times 10^{10}/cm^3$, and assume that for intrinsic silicon $\mu_n = 1350$ cm^2/V·s and $\mu_p = 480$ cm^2/V·s, and for the doped silicon $\mu_n = 1110$ cm^2/V·s and $\mu_p = 400$ cm^2/V·s.

29. a. Depict V-I characteristics of tunnel diode and explain the peak and valley voltage with energy level diagrams. Show the equivalent circuit of the Tunnel diode also.   12   1   2

   (OR)

   b. Identify the diode that works on the principle of the 'Transferred Electron Effect' and explain its structure. Show the energy band diagram and explain the V-I characteristics of the same.

30. a. Consider the circuit shown below and determine all node voltages and branch currents. Assume that β is specified to be 100.   12   3   3

(b)
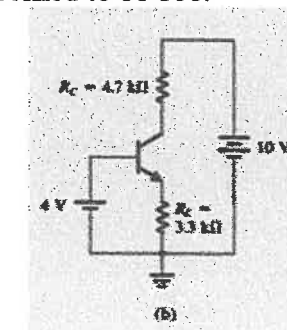
   (OR)

   b. Sketch and explain the input and output characteristics of common emitter and common collector configuration.

31. a. Determine the values of R_D and R_S so that the transistor operates at $I_D = 0.4$ mA and $V_D = +0.5$ V. The NMOS transistor has $V_{th} = 0.7$ V, $\mu_n C_{ox} = 100$ $\mu A/V^2$, L = 1 μm, and W = 32 μm. Neglect the channel-length modulation effect.   12   3   4
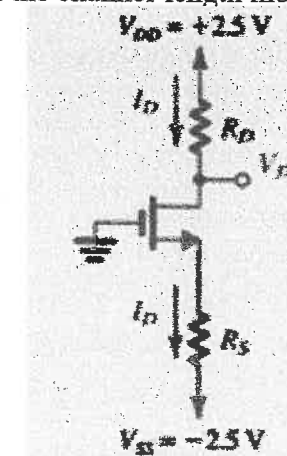
   (OR)

   b. Derive the expression for the drain current of E-MOSFET and state all the assumption clearly.