

Seat No. : _____

JG-122

June-2022

M.Sc., Sem.-II

409 : Physics

(Semiconductor Physics and Devices)

Time : 2 Hours]

[Max. Marks : 50

- Instructions :**
- (1) **All** questions in **Section – I** carry equal marks.
 - (2) Attempt any **three** questions in **Section – I**.
 - (3) Questions in **Section – II** is **COMPULSORY**.
 - (4) Symbols used have usual meanings.

SECTION – I

1. (A) Explain the formation of energy bands in semiconductor. Draw the energy band diagrams of metal, semiconductors and insulators. 7
(B) Prove that at any temperature, the location of Fermi level is at the centre of the forbidden gap in an intrinsic semiconductor. 7
2. (A) State and prove the law of mass action. Give its physical significance. 7
(B) Explain the formation of acceptor and donor states. Describe the effect of temperature on the Fermi level in p-type semiconductor. 7
3. (A) Draw the energy band diagram of a p-n junction at thermal equilibrium. Show that the location of the Fermi level is constant across the p-n junction. 7
(B) For an abrupt p-n junction assume a rectangular depletion region at thermal equilibrium. Obtain an expression of the built-in potential of the p-n junction. 7
4. (A) Obtain the Shokley equation of an ideal p-n junction diode. 7
(B) For an unbiased p-n junction, obtain an expression for depletion layer width. 7

5. (A) Define important JFET parameters and discuss the effect of temperature on drain current. A JFET has value of $g_{mo} = 3000\mu S$. Determine the value of g_m at $V_{GS} = -4V$. Given that $V_{GS(off)} = -8V$. 7
- (B) Give details of construction and working of **Enhancement type** N-channel MOSFET with suitable diagrams. Draw its output and transfer characteristics. 7
6. (A) Draw circuit of common gate amplifier using JFET and give its NORTON'S equivalent circuit. Write the expressions for its voltage gain, input and output resistances. The transconductance (g_m) of a JFET Common Gate amplifier is $3000\mu S$ and load resistance is $10k\ \Omega$. Find voltage gain of amplifier. 7
- (B) Write a note on Light Emitting Diode(LED). 7
7. (A) Draw schematic diagram of 2-input **TTL NAND** gate and explain its working by verifying the truth table. What should be done with floating input in TTL ICs ? 7
- (B) Discuss worst case input and output profile voltages of standard TTL IC. Explain the term "**noise margin**". 7
8. (A) Explain the concept of sourcing and sinking currents in TTL ICs ? Discuss standard loading rules for TTL ICs. 7
- (B) Draw schematic diagram of 2-input CMOS-NAND gate and explain its working by verifying the truth table. Write the main characteristics of CMOS ICs. 7

SECTION – II

9. Attempt the following MCQs : 8
- (1) For a JFET $I_{Gss} = 10\ nA$ at $V_{GS} = -10\ Volts$ and $V_{DS} = 0\ Volts$.
- The input resistance from Gate to Source is
- (A) $1\ M\Omega$ (B) $100\ M\Omega$
- (C) $1000\ M\Omega$ (D) $10000\ M\Omega$

- (2) An N-Channel Depletion MOSFET with positive V_{GS} is operational in
- (A) The Depletion mode (B) The Enhancement mode
(C) Saturation mode (D) Cutoff mode
- (3) Three CMOS gates are cascaded. If each has got the propagation delay time of 20ns, what is the total propagation delay time ?
- (A) 6.66 ns (B) 20 ns
(C) 60 ns (D) 8 μ s
- (4) What is the fanout of a standard TTL device driving a Low Power Schottky TTL Device (74LS) ?
- (A) 10 (B) 20
(C) 40 (D) 100
- (5) On which factors does the mobility of charge carriers depend ?
- (A) Purity of the materials (B) Type of the charge carriers
(C) Temperature (D) All of the above
- (6) With increase in temperature of an n-type semiconductor, the Fermi level location shifts towards the centre of the band gap due to
- (A) Increase in the kT value
(B) increase in the n_i having constant N
(C) increase in the N_D having constant n_i
(D) increase in the n_i and N_D both
- (7) If 10^{17} atoms \cdot cm $^{-3}$ antimony doped silicon possess the conductivity of $8.00 (\Omega\cdot\text{cm})^{-1}$, then its electron mobility will be
- (A) $500 \text{ cm}^2 \text{ V}^{-1}\text{S}^{-1}$ (B) $600 \text{ cm}^2 \text{ V}^{-1}\text{S}^{-1}$
(C) $700 \text{ cm}^2 \text{ V}^{-1}\text{S}^{-1}$ (D) $800 \text{ cm}^2 \text{ V}^{-1}\text{S}^{-1}$
- (8) From the C-V characteristics of a p-n junction, one may estimate _____.
- (A) Space charge region width (B) Built-in potential
(C) Charge carrier mobility (D) Band gap energy
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