

Reg No.: _____

Name: _____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
THIRD SEMESTER B.TECH DEGREE EXAMINATION, DECEMBER 2018

Course Code: EC203

Course Name: SOLID STATE DEVICES (EC, AE)

Max. Marks: 100

Duration: 3 Hours

PART A

Answer any two full questions, each carries 15 marks.

Marks

- 1 a) Define Hall effect. Derive the expressions for majority carrier concentration and mobility. (7)
- b) Explain the variation in energy levels of a semiconductor when an electric field is applied? (3)
- c) Consider a semiconductor bar with $w=0.1\text{mm}$, $t=10\mu\text{m}$ and $L=5\text{mm}$. For $B=10\text{kg}$ ($1\text{kg}=10^{-5}\text{Wb/cm}^2$) and a current 1mA , we have $V_{AB}=-2\text{mV}$, $V_{CD}=100\text{mV}$, Find the type, concentration, and mobility of the majority carrier. (5)
- 2 a) Prove that $n_0p_0 = ni^2$. (7)
- b) The Fermi level position in a Si sample at 300K is 0.29eV below E_c . Determine the carrier concentration and conductivity of the specimen. Given that $n_i=1.5 \times 10^{10}\text{cm}^{-3}$, $\mu_n=1350\text{cm}^2/\text{Vs}$, $\mu_p=480\text{cm}^2/\text{Vs}$. (8)
- 3 a) Derive an expression for drift current density. (7)
- b) Explain the effect of temperature on mobility. (3)
- c) Calculate the thermal equilibrium electron and hole concentration in Si at $T=300\text{K}$, when the Fermi energy level is 0.27eV below the conduction band edge E_c . The effective densities of states in the conduction band and valance band are $2.8 \times 10^{19}\text{cm}^{-3}$ & $1.04 \times 10^{19}\text{cm}^{-3}$ respectively at 300K. (5)

PART B

Answer any two full questions, each carries 15 marks.

- 4 a) Draw the energy band diagram of a p-n junction at a) equilibrium b) Forward bias c) Reverse bias. (6)
- b) Differentiate Ohmic contact and Rectifying contacts with neat diagram. (9)
- 5 a) Explain with neat diagrams (7)
 - (i) Zener breakdown.
 - (ii) Avalanche breakdown.

- b) With appropriate energy band diagram explain the operation of a tunnel diode. (8)
- 6 a) Determine the junction capacitance of a silicon pn junction at $T = 300\text{ K}$ when a reverse bias voltage of 5 V is applied across the junction. The doping concentrations of p&n regions are $8 \times 10^{21}\text{ m}^{-3}$ & $3 \times 10^{22}\text{ m}^{-3}$ respectively & the cross-sectional area of the junction is $5 \times 10^{-9}\text{ m}^2$. (Assume n_i for Si at 300 K is $1.5 \times 10^{10}\text{ cm}^{-3}$ and $\epsilon_r = 11.7$) (7)
- b) Derive the expression for open circuit contact potential of a p-n junction under equilibrium. (8)

PART C

Answer any two full questions, each carries 20 marks.

- 7 a) Derive the expression for drain current at saturation for a MOSFET. (8)
- b) Explain the basic performance parameters α , β & γ . (6)
- c) Explain early effect and early voltage. (6)
- 8 a) Derive the expression for minority carrier distribution in a pnp transistor. (10)
- b) Explain the principle of operation of MOS capacitor with suitable energy band diagram. (10)
- 9 a) Explain the principle of operation of FINFET with neat diagrams. (5)
- b) Plot the sub-threshold characteristics of MOSFET and explain. (5)
- c) Describe the C-V Characteristics of an Ideal MOS capacitor. Derive the expression for threshold voltage. (10)
