

Reg No.: _____

Name: _____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
THIRD SEMESTER B.TECH DEGREE EXAMINATION, DECEMBER 2017

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) Derive the expression for electron, hole and intrinsic concentrations at equilibrium in terms of effective density of states. Formulate the relation between these concentrations at equilibrium. (8)
- b) A Silicon sample is doped with 10^{17} boron atoms/cm³. What is the equilibrium electron and hole concentrations at 300K? Where is E_F relative to E_i . Draw the energy band diagram. Intrinsic carrier concentration of Silicon is 1.5×10^{10} at 300K. (7)
- 2 a) A Silicon bar of 100 cm long and 1 cm² cross sectional area is doped with 10^{17} Arsenic atoms/cm³. Calculate electron and hole concentrations at 300K. Also find the conductivity and the current with 10V applied. Electron mobility at this doping is 700 cm²/V-sec. (7)
- b) What is Hall effect? Derive the expression for carrier concentration and mobility in terms of Hall voltage. (8)
- 3 a) Describe diffusion process. Derive the expression for diffusion current density. (7)
- b) Prove that under steady state carrier injection, the injected excess carrier concentration is an exponentially decreasing function of distance. (8)

PART B

Answer any two full questions, each carries 15 marks.

- 4 a) Draw the energy band diagram of a PN junction (6)
 - i) at equilibrium, ii) under forward bias and iii) under reverse bias.
- b) A Silicon sample having circular cross section with diameter 10μm is doped with 10^{18} cm⁻³ acceptor impurities on one side and 5×10^{15} cm⁻³ donor impurities on the other side. If the sample is at equilibrium, calculate contact potential, width of depletion region, penetration of depletion region on both N side and P side, and total charge on both N side and P side at 300K. (9)
- 5 a) An abrupt Silicon PN junction has the following parameters at 300K. (10)

P side:- $N_a=10^{17}$ cm⁻³, $\tau_n=0.145$, $\mu_n= 700$ cm²/V-sec.
N side:- $N_d=10^{15}$ cm⁻³, $\tau_p=1045$, $\mu_p= 450$ cm²/V-sec.

The junction is forward biased by 0.5V. What is the forward current. What is the current at reverse bias of (-0.5V).
- b) Differentiate between ohmic and rectifying contacts. (5)
- 6 a) Derive the expression for depletion and diffusion capacitance of a PN junction. (7)
- b) With the help of necessary diagrams, explain the working of a tunnel diode. (8)

PART C

Answer any two full questions, each carries 20 marks.

- 7 a) Derive the expression for minority carrier distribution and terminal currents in a transistor. (12)
- b) Describe early effect in a transistor. (5)
- c) What are the factors which cause base current in a transistor? (3)
- 8 a) With the help of necessary band diagrams, explain equilibrium, accumulation, depletion and inversion stages of a MOS capacitor. (12)
- b) What are the effect of real surfaces of a MOS capacitor. (4)
- c) Draw and explain the structure of FINFET. (4)
- 9 a) Derive the expression for drain current of a MOSFET. (10)
- b) Draw and explain the transfer characteristics of an n-channel MOSFET. (5)
- c) A Silicon n-channel MOSFET has $\mu_n = 600 \text{ cm}^2/\text{V}\cdot\text{sec}$, $C_{\text{ox}} = 1.2 \times 10^{17} \text{ F/cm}^2$, $z=50 \mu\text{m}$, $L=10 \mu\text{m}$ and $V_{\text{TH}} = 0.8\text{V}$. Find the drain current when
- i) $V_{\text{GS}}=2\text{V}$ and $V_{\text{DS}}=1\text{V}$ ii) $V_{\text{GS}}=3\text{V}$ and $V_{\text{DS}}=5\text{V}$
