

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/cm<sup>3</sup>. 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  $1.5 \times 10^{10}$  at 300K. (7)
- 2 a) A Silicon bar of 100 cm long and 1 cm<sup>2</sup> cross sectional area is doped with  $10^{17}$  Arsenic atoms/cm<sup>3</sup>. Calculate electron and hole concentrations at 300K. Also find the conductivity and the current with 10V applied. Electron mobility at this doping is 700 cm<sup>2</sup>/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<sup>-3</sup> acceptor impurities on one side and  $5 \times 10^{15}$  cm<sup>-3</sup> 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<sup>-3</sup>,  $\tau_n = 0.145$ ,  $\mu_n = 700$  cm<sup>2</sup>/V-sec.  
N side:-  $N_d = 10^{15}$  cm<sup>-3</sup>,  $\tau_p = 1045$ ,  $\mu_p = 450$  cm<sup>2</sup>/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  $\mu_n = 600 \text{ cm}^2/\text{V}\cdot\text{sec}$ ,  $C_{ox} = 1.2 \times 10^{17} \text{ F/cm}^2$ ,  $z = 50 \mu\text{m}$ ,  $L = 10 \mu\text{m}$  and  $V_{TH} = 0.8\text{V}$ . Find the drain current when
- i)  $V_{GS} = 2\text{V}$  and  $V_{DS} = 1\text{V}$                       ii)  $V_{GS} = 3\text{V}$  and  $V_{DS} = 5\text{V}$

\*\*\*\*

