Registration No: | | | | | | | | | | |

Total Number of Pages:02 **B.Tech**
PET3I001

3rd Semester Regular / Back Examination 2017-18
Semiconductor Devices
BRANCH: ECE, ETC
Time: 3 Hours
Max Marks: 100
Q.CODE: B983

Answer Question No.1 and 2 which are compulsory and any four from the rest.
The figures in the right hand margin indicate marks.

Q1 **Answer the following questions: *multiple type or dash fill up type*** **(2 x 10)**

a) The bandgap energy of Si is --------- and the bandgap energy of Ge is -------.
b) If the semiconductor is doped with $N_D=1x10^{16}/cm^3$, the materials becomes ----, and if doped with $N_A=1x10^{16}/cm^3$, the material becomes ----------.
c) Addition of N_D in a semiconductor material, the fermi energy is moving towards ---------- and addition of $N_A$in the semiconductor material the fermi energy is moving towards ----------.
d) The dopants are added in the Si in the ratio of 10^6:1. The donner concentration of material will be ----------.
e) Complete elevation of electrons from donner state to conduction band is called ----------.
f) There are --------- and ---------- mechanisms in a semiconductor affect the carrier mobility.
g) The drift current density due to electrons is ---------- and the diffusion current density due to electrons is ----------.
h) The unit of conductivity is --------- and the unit of resistivity is ----------.
i) Typical electron mobility value at 300 K and low doping for Si is ---------- and for Ge is ----------.
j) BJT is a ---------- device and MOSFET is a ---------- device.

Q2 **Answer the following questions: *Short answer type*** **(2 x 10)**

a) Define work function for the semiconductor?
b) What do mean by the majority carriers and minority carriers ?
c) Consider an N-type Si semiconductor at T=300K in which $N_D=10^{16}/cm^3$, $N_A=0$, $n_i=1.5x10^{10}$ cm^3. Find out electron concertation ?
d) What do mean by compensated semiconductor ?
e) Plot the variation of E_F with doping concertation and temperature.
f) Write down the relation between the diffusion coefficient and mobility?
g) Sketch the drift velocity of electron in silicon versus electric filed.
h) Why are the electron generation rate and recombination rate equal in thermal equilibrium ?
i) Why does the potential barrier decreases in a forward biased PN junction ?
j) Explain the physical mechanisms of the current gain limiting factors of the BJT

Q3 **a)** Derive the equation for the thermal equilibrium concentration of electrons (n_0) and thermal equilibrium concentration of holes (p_0). **(10)**
b) If the fermi energy is 0.27 eV above valence band energy, calculate the thermal equilibrium hole concentration in silicon at T=400K. The value of $N_V=1.04x10^{19}/cm^3$ for Si at T=300K. **(5)**

Q4 **a)** Derive the Einstein relation ? **(10)**
b) A particular intrinsic semiconductor has a resistivity of 50 ohm-cm at T=300K and 5 ohm-cm at T=330 K. Neglecting the change in mobility with temperature, determine the band gap energy of the semiconductor? **(5)**

Q5 **a)** Derive the built in potential barrier for a PN junction diode ? **(10)**

b) Calculate, the width of the space charge region in a PN junction when a reverse bias voltage of 5 V is applied. Assuming Si PN junction at T=300K with doping concentrations $N_A = 10^{16}/cm^3$ and $N_D = 10^{15}/cm^3$, $n_i = 1.5 \times 10^{10}/cm^3$. **(5)**

Q6 **a)** Derive the ideal current-voltage relationship for a PN junction diode? **(10)**

b) Differentiate between shot diode and long diode ? **(5)**

Q7 **a)** Describe the time delay factors in the frequency limitation of the bipolar transistor ? **(10)**

b) A Si NPN transistor at T=300K is given assuming the following parameters. $I_E = 1mA$, $X_B = 0.5\mu m$, $X_C = 2.4\mu m$, $C_\mu = 0.1\mu F$, $C_{je} = 1pF$, $D_n = 25cm^2/sec$, $r_c = 20\Omega$, $C_s = 0.1pF$. Calculate the emitter to collector transit time and cut-off frequency. **(5)**

Q8 **a)** Define the threshold voltage. Derive the threshold voltage of MOSFET? **(10)**

b) The parameters of an n-channel MOSFET are $\mu_n = 650cm^2/v\text{-}s$, $t_{ox} = 200\text{Å}$, (W/L) =50, and $V_t = 0.40$ V. If the transistor is biased in the saturation region find the drain current for Vgs=1.2 V. **(5)**

Q9 **a)** Discuss with diagram the C-V characteristics of an MOS capacitor under high and low frequency conditions. **(10)**

b) Consider an aluminum gate–Silicon dioxide-P type Silicon MOS structure with $t_{ox} = 450$ Å. The silicon doping is ,$N_A = 2 \times 10^{16}/cm^3$ and the flat band voltage, $V_{FB} = -1$ V. determine the fixed oxide charges Q'_{ss}. **(5)**