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

Total Number of Pages : 02 **M.Sc**

BSCP1207

3rd Semester Back Examination 2018-19

PHYSICS OF SEMICONDUCTOR DEVICES

BRANCH : AEIE, BIOTECH, CSE, ECE, EEE, EIE, ELECTRICAL, ETC, IEE, IT, ITE

Time : 3 Hours

Max Marks : 70

Q.CODE : E757

Answer Question No.1 which is compulsory and any five from the rest.

The figures in the right hand margin indicate marks.

Q1 **Answer the following questions :** **(2 x 10)**

a) Differentiate between conductor, semiconductor and insulator in terms of energy bands.

b) Draw k-space diagrams of Si and GaAs.

c) Write the expression for Fermi-Dirac distribution function.

d) What do you mean by conductivity and resistivity?

e) What do you mean by Ohmic contact..

f) Differentiate n-type MOSFET from p-type MOSFET.

g) Differentiate between drift and diffusion current.

h) A BJT has $I_C = 2mA$ & $I_B = 5\mu A$. Determine the value of I_E, β_F and α_F.

i) Differentiate between homogeneous and heterogeneous junction by examples.

j) Compare graphically the I-V characteristics of Schottky barrier diode & pn-junction diode. Between them which has less effective turn on voltage?

Q2 **a)** Derive an expression for electron effective mass. Write its characteristics. **(5)**

b) Find (E, K) relationship for free electron and relate it to the electron mass. **(5)**

Q3 **a)** Derive the expression for the thermal equilibrium concentration of holes in the valence band using effective density of states, Fermi energy and Fermi function. **(6)**

b) Establish the equation $n_0 p_0 = n_i^2$. Terms carrying their usual meaning. **(4)**

Q4 **a)** Derive *Einstein relation* between diffusion coefficient and mobility. **(7)**

b) Assuming the mobility of a particular carrier as 1000 cm^2/v-s at a temperature of 300 K, determine the diffusion coefficient. **(3)**

Q5 **a)** Derive an expression for Built in potential barrier for a pn-junction diode in thermal equilibrium. **(6)**

b) Calculate built in potential barrier in a silicon pn-junction at T= 300 K for doping densities $N_a = 10^{18} cm^{-3}$ and $N_d = 10^{15} cm^{-3}$. Assuming $n_i = 1.5 \times 10^{10} cm^{-3}$ **(4)**

Q6 **a)** What is Ebers-Moll model? Using Kirchhoff's current law, obtain the expression for Ebers-Moll equations. **(5)**

b) Explain the basic operation of bipolar junction transistor. **(5)**

Q7 **a)** What do you mean by CMOS Technology? Draw the cross section of a CMOS structure. Discuss what is meant by Latch-up in a CMOS structure. **(5)**

b) Calculate the flat band voltage for an MOS capacitor with a p-type semiconductor substrate doped to $N_a = 10^{16} cm^{-3}$, a silicon dioxide insulator with a thickness of $t_{ox} = 500 \overset{0}{\text{A}}$, and an n+ polysilicon gate with oxide charge of $Q'_{ss} = 10^{11}$ electronic charges per cm^2 and metal to semiconductor work function differences as -1.1 V. **(5)**

Q8 **Write short answer on any TWO :** **(5 x 2)**

a) Avalanche breakdown.

b) Early Effect.

c) Base width modulation

d) Schottky Barrier Diode.