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

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B.TECH
PET3I001

3rd Semester Regular Examination 2016-17

SEMICONDUCTOR DEVICES

BRANCH(S): ECE, ETC
Time: 3 Hours
Max Marks: 100
Q.CODE: Y704

Answer Part-A which is compulsory And any four from Part-B.
The figures in the right hand margin indicate the marks.

Part – A (Answer all the questions)

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

a) In modern MOSFET, the material is used for gate is …………….
(i)high purity silicon (ii) high purity silica (iii) heavily doped polycrystalline silicon (iv) epitaxial grown silicon

b) Majority carriers are many times activated by ……………
(i)dopnats (ii) pressure (iii) heat (iv)forward bias

c) Which semiconductor is made of coal gas?
(i)Silicon (ii) carbon (iii) Germanium (iv) tin

d) Which capacitance dominates in the reverse bias region?
(i)depletion (ii) conversion (iii) accumulation (iv) diffusion

e) The current can be investigated in SBD by the process of …………..
(i)diffusion (ii) drift (iii) thermionic emission (iv) ionization

f) In which region the temporal response of an MOS capacitor is slowest.
(i)accumulation (ii) flat band (iii) inversion (iv) depletion

g) The energy gap of gallium arsenide at T=300 K is …………….
(i)1.42 eV (ii) 1.42MeV (iii) 1.42 meV (iv) 1.42 J

h) Switching time of Schottky barrier and pn junction diode are the order of …… and ……….
(i) pico, nano (ii) nano, pico (iii) nano , nano (iv) pico , pico

i) How many orbiting electrons does the germanium have?
(i)4 (ii)14 (iii) 32 (iv) 41

j) A germanium transistor has the Q point corresponding to i_B=300 μA and I_c=1.3 mA. The common emitter gain is ……………
(i)4.33 (ii) 43.33 (iii) 433.3 (iv) 0.433

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

a) An electronic engineer is searching a low band gap semiconductor material for showing its transparency behavior at third communication window (λ= 1550 nm). What will be the energy gap of above semiconductor at same communication window?

b) How does long and short diode depend on diffusion length and neutral region length?

c) Draw energy band diagram of pn junction in thermal equilibrium and under reverse bias condition.

d) Identify the necessary conditions for one sided junction diode.

e) The fundamental equation for semiconductor is given by
$n_0 p_o = n_i^2$ (Symbols have their usual meaning).
Interpret the above equation.

f) What do you mean by base width modulation? Plot a graphical representation for envisaging early effect.

g) The charge neutrality equation for MOS capacitor is given by $Q_m + Q_{ss} = 0$.
(Symbols have their meaning).
Elaborate the above statement.

h) Difference between rectifying and non-rectifying barrier.

i) Show a graph for comparing the forward bias IV characteristics of SBD and PND.

j) Find out the thermal equilibrium electron concentration in GaAs at $E_f = E_c$.

<u>Part – B (Answer any four questions)</u>

Q3 **a)** Discuss metal-semiconductor junction device. Study current-voltage characteristics from it **(10)**

b) A pn junction diode and Schottky barrier diode have equal cross sectional area and have forward biased current of 0.5 mA. The reverse saturation current of the Schottky diode 9 nA. The difference forward bias between two diode is 0.3 V. Determine the reverse saturation current of the pn junction diode. **(5)**

Q4 a) Draw the energy band diagram of MOS capacitor. Discuss C-V characteristics of the MOS capacitor for different operating conditions **(10)**

b) Write short notes on flat band condition including supporting expression and diagram. **(5)**

Q5 a) Derive an expression for concentration of electron and hole in compensated semiconductor. **(10)**

b) How does Fermi energy level vary with doping concentration and temperature? Mention the mathematical equations for the same. **(5)**

Q6 a) A pn junction profile is shown in figure 6(a) at zero bias. **(10)**

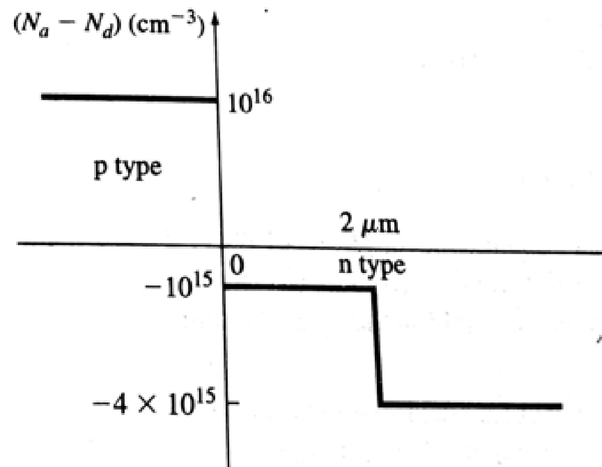

Figure 6(a)

Determine the following

(i) built-in potential

(ii) Width of the depletion region

(iii) Draw energy band diagram corresponding to above graph.

(iv) Plotelectricfield versus distance of the junction

b) Draw and explain the structure of n and p-MOS transistor. **(5)**

Q7 a) Mathematically describe for excess minority carrier expression in base region in forward active mode for n-p-n transistor. Also obtain an equation for collector current. **(10)**

b) The emitter and base f a silicon npn transistor are uniformly doped at impurity concentration of 10^{17} cm^{-3} and 10^{15} cm^{-3} respectively at V_{BE}=0.75 V having base width of 1 μm and diffusion length L_B=5 μm. Calculate the excess minority carrier concentration at (i) x=0 (b) x=0.25W_B. **(5)**

Q8 **a)** Consider a semiconductor thermal equilibrium, where no realization of electric current with the same. Assume that the donor concentration varies exponentially as $N_d(x)=N_{d0}e^{-\alpha x}$ over the range of $[0,\alpha]$, N_{d0} is constant. Calculate: **(10)**

(i) Calculate the electric-field over the same range.

(ii) Find out the potential difference between 0 to α

b) Derive an expression for Einstein relation of semiconductor. **(5)**

Q9 **a)** Differentiate drift current from diffusion. Write mathematical expressions for each. Show graphically electron, hole diffusion and drift current densities. **(10)**

b) The hole concentration in silicon at T=300 K varies as $p(x)=10^{18}\ e^{-0.096x}\ cm^{-3}$, where x is meter in nm. If the hole diffusion coefficient is $0.36\ cm^2s^{-1}$, then determine the diffusion current density as a function of x. **(5)**