Shri Vile Parle Kelvani Mandal's
Dwarkadas J. Sanghvi College of Engineering
Approved by AICTE, New Delhi and Affiliated to the University of Mumbai

Department of Electronics Engineering

Academic Year : 2015

MID-TERM TEST I

Subject : Electronic Devices

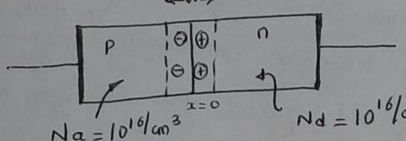
SE Sem III

Date: 09/09/2015
Marks: 20

Time: 1 hour

Note: Attempt any two questions:

Q1. Given a uniformly doped p-n junction (Si) in thermal equilibrium:



at T = 300K

$N_a = 10^{16}/cm^3$ $N_d = 10^{16}/cm^3$

$V_{bi} = V_t \ln\left[\frac{N_a N_d}{n_i^2}\right]$

a) Derive the expression for build-in potential (2m)

b) From the given information calculate V_{bi} → 0.697V. (1m)

c) Draw EBD of given device under i) equilibrium (2m) and ii) under reverse-bias

$W = \left[\frac{2\epsilon_s V_{bi}}{q}\left(\frac{N_a + N_d}{N_a N_d}\right)\right]^{1/2}$

d) Find 'W' for zero-applied bias and a reverse (2m) bias of 8V.

$W = 4.17\times10^{-5}$ cm | 0V

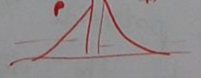
$W = 1.47\times10^{-4}$ cm | 8V.

e) Find max E-field strength under equilibrium (1m)

$E_m = \frac{-2V_{bi}}{W} = -33.4$ kV/cm

f) Draw MCD for given device (1m)

g) State any 4 ideal pn junction assumption (1m)



Given Data:

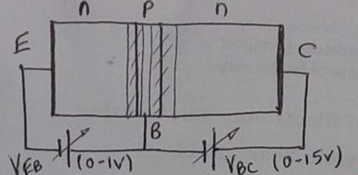
$q = 1.6\times10^{-19}$ C

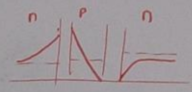
$n_i = 1.5\times10^{10}/cm^3$

$\epsilon_{si} = 11.7\times 8.854\times10^{-14}$

— Turn Over —

Q2.



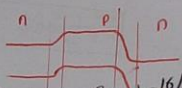


→ Forward-active mode

a) Given device is connected in which mode? (1m)

b) Draw MCD in this mode? (1m)

c) Draw EBD in this mode? (1m)



d) If doping in emitter is $5\times10^{17}/cm^3$, base is $10^{16}/cm^3$ and collector is $10^{15}/cm^3$. Find the values of (2m)

P_{EO}, n_{BO} and P_{CO}?

$\frac{n_i^2}{N_E}$ $4.5\times10^2/cm^3$; $\frac{n_i^2}{N_B}$ $2.25\times10^4/cm^3$; $2.25\times10^5/cm^3$ $\frac{n_i^2}{N_C}$

e) Explain the terms γ, b and δ w.r.t BJT (1m)

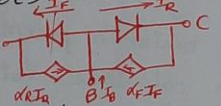
$\frac{I_{En}}{I_{En}+I_{Ep}}$; I_{Cn}/I_{En} ; $\frac{I_{En}+I_{Ep}}{I_{En}+I_R+I_{Ep}}$

f) Name various non-ideal effects in a BJT (1m)

→ BWM, HLI, Non-uniform Base doping, Breakdown vtg, Emitter bandgap narrowing

g) Explain emitter bandgap narrowing. (2m)

h) Draw Eber's-moll model for an npn BJT (1m)



Q3.

a) Explain and then draw an model for BJT which accounts for low and high frequency effects (5m)

→ hybrid-π model

b) Attempt the following questions.

i) The depletion capacitance C_j of an abrupt pn-junction varies with reverse bias as (1m)

A] $C_j \propto V_R$

B] $C_j \propto V_R^{-1}$

C] $C_j \propto V_R^{-1/2}$ ✓

D] $C_j \propto V_R^{-1/3}$

ii) The build-in potential in a pn-junction. (1m)

A] is equal to the difference in the fermi-level of the two sides, expressed in volts

B] increases with increase in doping levels

C] increases with increase in temperature

D] all of these ✓

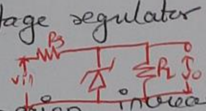
— Turn over —

Q3. b)

$$I_D = I_S\left[\exp\left(\frac{V_D}{\eta V_T}\right) - 1\right]$$

iii) A pn-junction diode has reverse-saturation current 10^{-10} A and $\eta = 2$ (ideality factor). If diode forward voltage is 0.9V, then diode forward current is ______ 3.285 mA. (1m)

iv) Explain how zener works as voltage regulator? (2m)



OR

iv) a) The width of space charge region increases as the applied reverse voltage increases. (2m)

b) Avalanche breakdown diodes have breakdown voltage

i) having positive temperature co-efficient ✓

ii) having negative temperature co-efficient

iii) independent of temperature

iv) None of these

—— x —— x ——