American University of Beirut

Department of Electrical and Computer Engineering

EECE 310 – Electronics Fall 2011 – 2012

*Due Wednesday November 2, 2011 at 9:00 am*

**Homework 5**

**1. [50 points]**

a. [20 points] Find and plot the transfer characteristics (*vo* versus *vs*) of the circuit shown below. Label all important points, including breakpoints, in the graph.   
Assume that when conducting in the forward direction, diodes drop 0.75 V.



b. [15 points] Verify the results of part (a) using PSpice. Use a *DC Sweep* for *vs* ranging from –30 Volts to +30 Volts in steps of 10 mV.

c. [15 points] Plot and label the graph of the output voltage versus time, *vo*(*t*), when the source *vs* is as given below.

t

v

s

(

t

) (

Volts

)

25

V

-

25

V

T

2

T

*Assume in the following that T = 300 degrees K*

**2. [20 points]**

The maximum drift velocity of carriers in silicon is approximately 107 cm/sec.

1. [5 points] What is the maximum drift current density that can be supported in an *n*-type silicon sample with a doping level of 3.5×1017 cm-3 ?
2. [10 points] What is the conductivity of the silicon sample? What is its resistivity? Assume that the mobility of electrons is 950 cm2/V.sec.
3. [5 points] What is the corresponding voltage drop across the sample if it has a length of 15 cm?

**3. [15 points]**

The free electron concentration in a silicon sample is described by:

 free electrons per cm3 with *Ln* equal to 2.5 m.

1. [10 points] Find the diffusion current density for electrons as a function of distance if *Dn* = 13 cm2/sec.
2. [5 points] What is the diffusion current at *x* = 0.75*Ln* if the cross sectional area is 5000 m2 ?

**4. [15 points]**

A PN junction diode is doped with *NA* = 2×1017 cm-3 on the *p* side and   
*ND* = 7×1015 cm-3 on the *n* side.

1. [5 points] What are the hole densities in the *p*-type and in the *n*-type regions?
2. [5 points] What are the free electron densities in the *p*-type and in the *n*-type regions?
3. [5 points] What is the built-in potential barrier?