ED ASSIGNMENT-2

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QUESTION 1

```
v1 1 0 dc=5
d1 1 2 D1N750
r1 2 0 1k
.model D1N750 D(Vj=.653 Cjo=175p Rs=.25 Eg=1.11 M=.5516 Nbv=1.6989 N=1 Bv=8.1 Fc=.5
Ikf=0 Ibv=20.245m Is=980.356E-20 Xti=3)
.save all @d1[id]
.dc v1 -10 5 0.05
* Control Statements
.control
 run
*white background
set color0=white
* black grid and text
set color1=black
* wider grid and plot lines
set xbrushwidth=2
plot @d1[id] vs v(1)
.endc
.end
```

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Q1) (a) Built-in potential :-

$$V_0 = V_T \ln\left(\frac{N_A N_D}{n_i^2}\right)$$

$N_A = 10^{15}/cm^3$

$N_D = 2\times10^{16}/cm^3$

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

$$= \frac{kT}{q} \cdot \ln\left(\frac{N_A N_D}{n_i^2}\right)$$

$$= \frac{1.38\times10^{-23}\times300}{1.6\times10^{-19}} \cdot \ln\left(\frac{2\times10^{31}}{2.25\times10^{20}}\right)$$

$$= 0.0259\left(11\ln10 + \left(\ln(2/2.25)\right)\right)$$

$$= 0.0259\left(11(2.303) - 0.118\right)$$

$$= 0.0259\,(25.2152)$$

$$\cong \boxed{0.653\,V}$$

(b) Reverse Saturation current:-

$$J_s = e n_i^2 \left[\frac{1}{N_a} \sqrt{\frac{D_n}{\tau_{no}}} + \frac{1}{N_d} \sqrt{\frac{D_p}{\tau_{po}}} \right]$$

$$= 1.6 \times 10^{-19} \times 2.25 \times 10^{20} \left[\frac{1}{10^{15}} \sqrt{\frac{35}{5 \times 10^{-6}}} + \frac{1}{2 \times 10^{16}} \sqrt{\frac{12}{5 \times 10^{-6}}} \right]$$

$D_n = 35 cm^2/s$
$D_p = 12 cm^2/s$
$\tau_{po} \& \tau_{no} = 5 \times 10^{-6} s$

$$= 3.6 \times 10 \left[\frac{\sqrt{7}}{10^{12}} + \sqrt{\frac{3}{5}} \frac{1}{10^{13}} \right]$$

$$= 36 \left[2.646 \times 10^{-12} + 0.774 \times 10^{-13} \right]$$

$$= 36 \left[26.46 \times 10^{-13} + 0.774 \times 10^{-13} \right]$$

$$= 980.356 \times 10^{-13}$$

Now, Area:- $10 \mu m^2 = 10 \times 10^{-6} m^2$

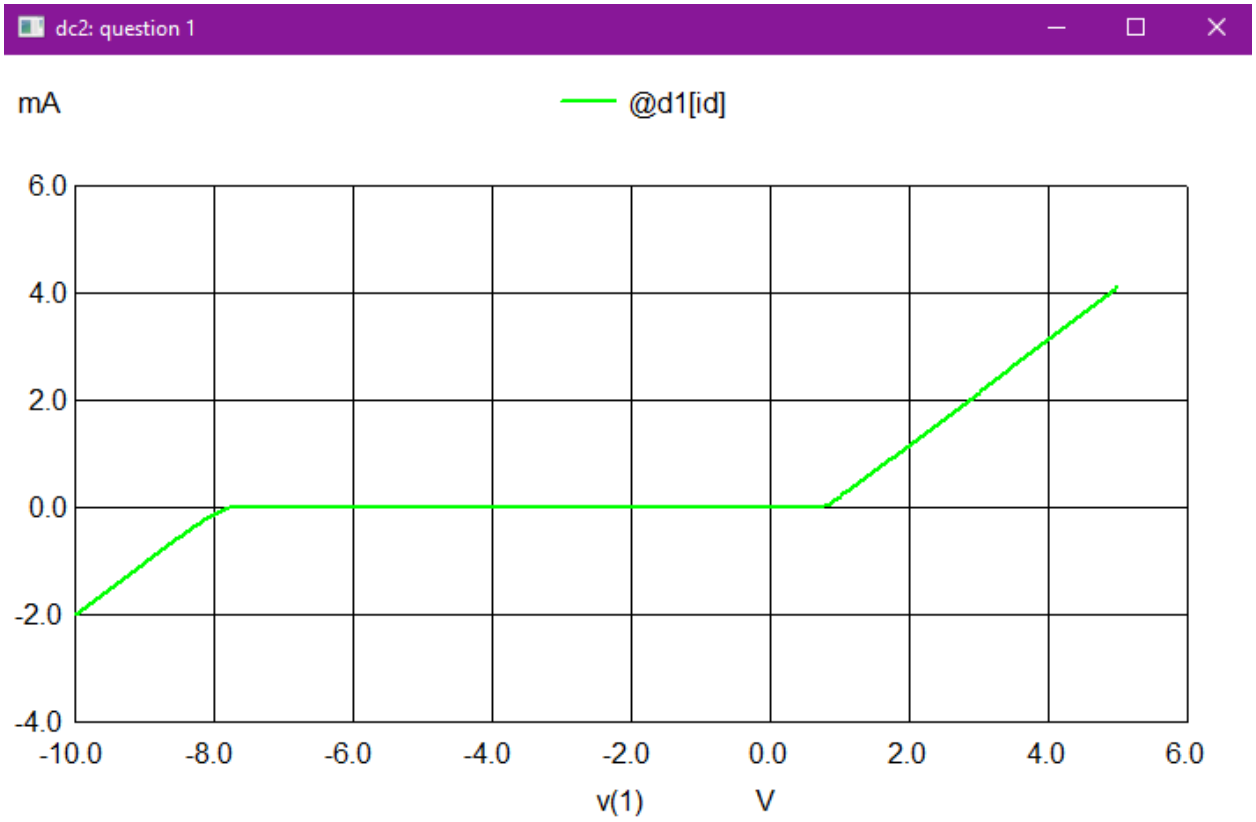
$$= (\sqrt{10} \times 10^{-3} m)^2$$

$$= (\sqrt{10} \times 10^{-3} \times 10^2 cm)^2$$

$$= 10 \times 10^{-8} cm^2 = 10^{-7} cm^2$$

$\Rightarrow I_s = J_s \times$ Area

$$= \boxed{980.356 \times 10^{-20} A}$$

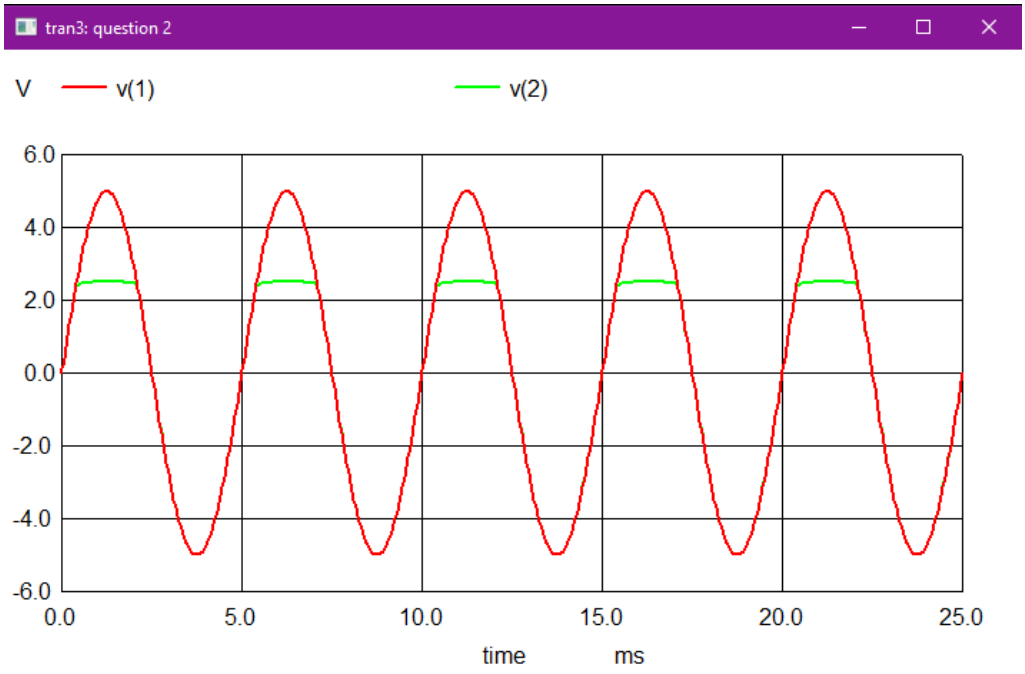


Interpretation:

The I-V Characteristics in the graph suggest that, roughly, the current is positive for positive voltage, and then, after a breakdown point, becomes negative. Under forward bias, the current is positive and is increasing as voltage is increasing, and under reverse bias, after the breakdown point, the current becomes more and more negative.

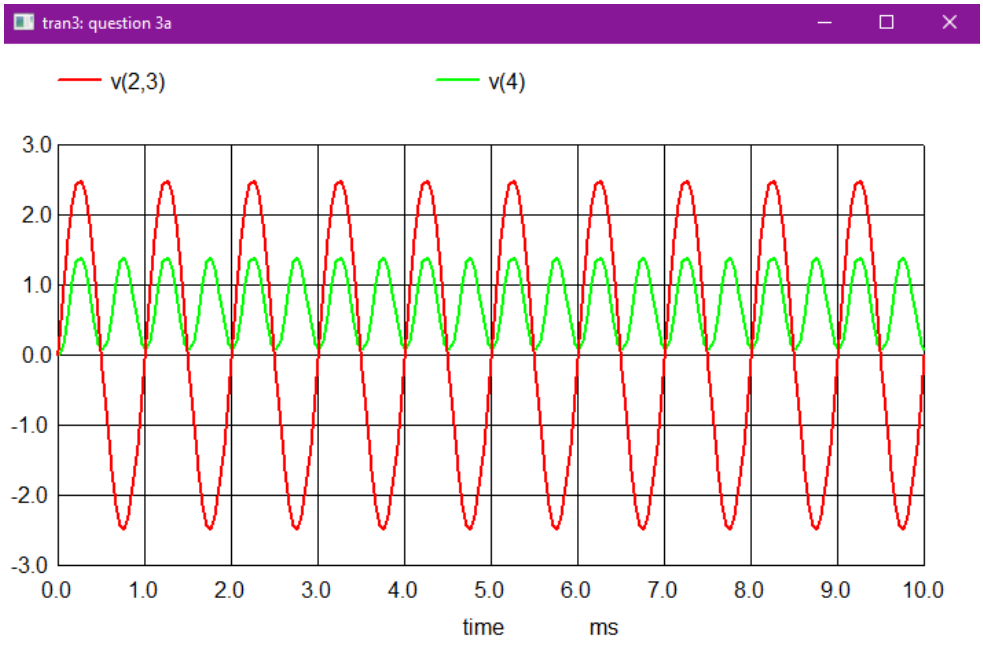
QUESTION 2

```
v1 1 0 dc=0 sin(0 5 200 0 0 0)
.ac lin 10 0.5 1Meg
.tran 0.05ms 25ms
v2 3 0 dc=2
d1 2 3 D1N750
r1 2 1 1000
.model D1N750 D(Vj=.653 Cjo=175p Rs=.25 Eg=1.11 M=.5516 Nbv=1.6989 N=1 Bv=8.1 Fc=.5
Ikf=0 Ibv=20.245m Is=980.356E-14 Xti=3)
* Control Statements
.control
 run
*white background
set color0=white
* black grid and text
set color1=black
* wider grid and plot lines
set xbrushwidth=2
plot v(2) v(1)
.endc
.end
```


tran3: question 2
V
v(1)
v(2)
6.0
4.0
2.0
0.0
-2.0
-4.0
-6.0
0.0
5.0
10.0
15.0
20.0
25.0
time
ms

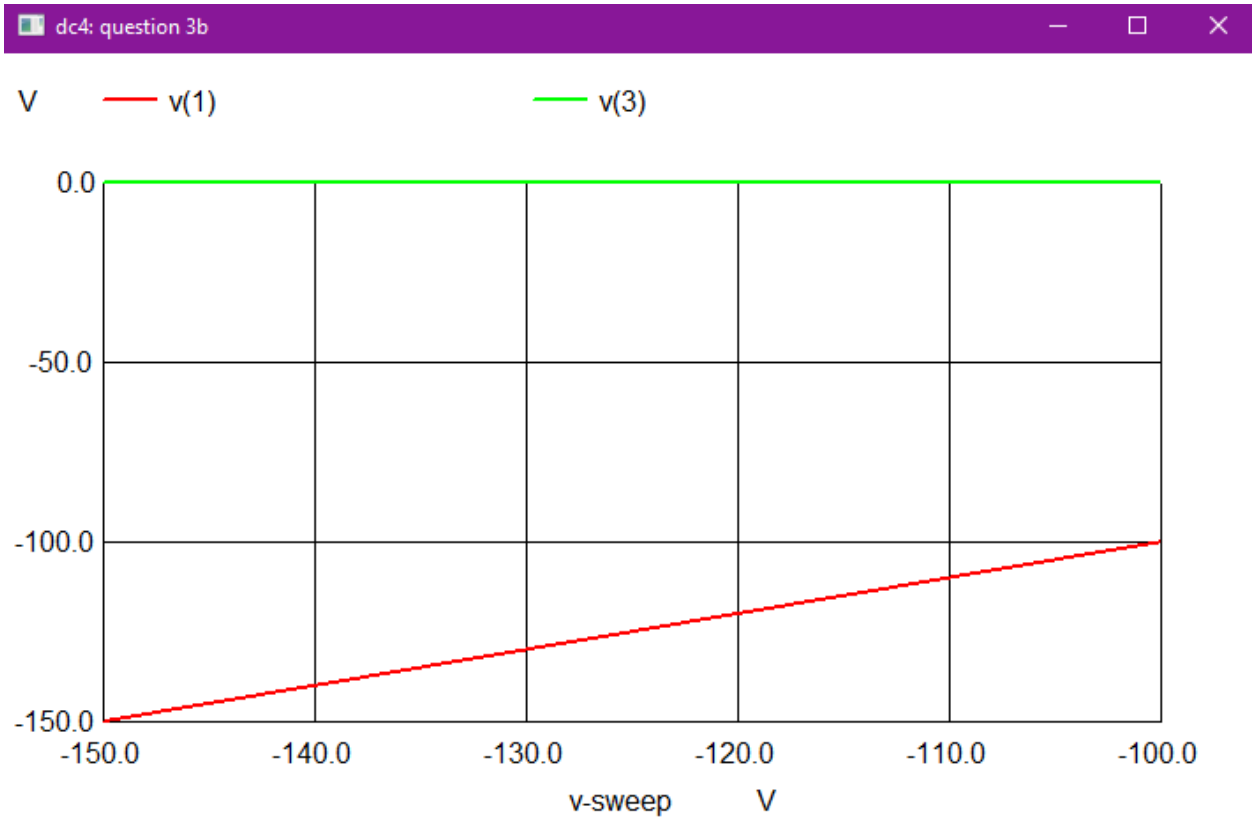
QUESTION 3A

```
v1 2 3 sin(0 2.5 1000 0 0 0)
.ac lin 10 0.5 1Meg
.tran 0.05ms 10ms
d1 0 2 D1N750
d2 2 4 D1N750
d3 0 3 D1N750
d4 3 4 D1N750
r1 4 0 1Meg
.model D1N750 D(Vj=.75 Cjo=175p Rs=.25 Eg=1.11 M=.5516 Nbv=1.6989 N=1 Bv=8.1 Fc=.5
Ikf=0 Ibv=20.245m Is=880.5E-18 Xti=3)
* Control Statements
.control
 run
*white background
set color0=white
* black grid and text
set color1=black
* wider grid and plot lines
set xbrushwidth=2
plot v(4) v(2,3)
.endc
.end
```



QUESTION 3B

```
v1 1 0 dc=-100
.dc v1 -150 -100 0.05
d1 0 2 D1N4148
r1 1 2 1000
r2 3 0 1Meg
.model D1N4148 D(Is=5.84n N=1.94 Rs=.7017 Ikf=44.17m Xti=3 Eg=1.11 Cjo=.95p+ M=.55
Vj=.75 Fc=.5 Isr=11.07n Nr=2.088 Bv=100 Ibv=100u Tt=11.07n)
* Control Statements
.control
 run
*white background
set color0=white
* black grid and text
set color1=black
* wider grid and plot lines
set xbrushwidth=2
plot v(3) v(1)
.endc
.end
```



QUESTION 3C

```
v1 2 3 sin(0 2.5 1000 0 0 0)
.ac lin 10 0.5 1Meg
.tran 0.05ms 10ms
d1 0 2 D1N750
d2 2 5 D1N750
d3 0 3 D1N750
d4 3 5 D1N750

.model D1N750 D(Vj=.75 Cjo=175p Rs=.25 Eg=1.11 M=.5516 Nbv=1.6989 N=1 Bv=8.1 Fc=.5
Ikf=0 Ibv=20.245m Is=880.5E-18 Xti=3)
v1 1 0 dc=-100
.dc v1 -150 -00 0.05
d1 0 5 D1N4148
r3 4 5 1000
r2 5 0 1Meg
.model D1N4148 D(Is=5.84n N=1.94 Rs=.7017 Ikf=44.17m Xti=3 Eg=1.11 Cjo=.95p+ M=.55
Vj=.75 Fc=.5 Isr=11.07n Nr=2.088 Bv=100 Ibv=100u Tt=11.07n)
* Control Statements
.control
 run
*white background
set color0=white
* black grid and text
set color1=black
* wider grid and plot lines
set xbrushwidth=2
plot v(5) v(2,3)
.endc
.end
```