Assignment 1

Mos dmc

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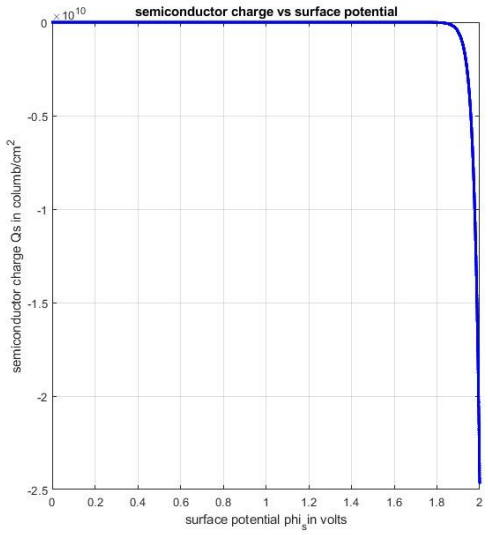
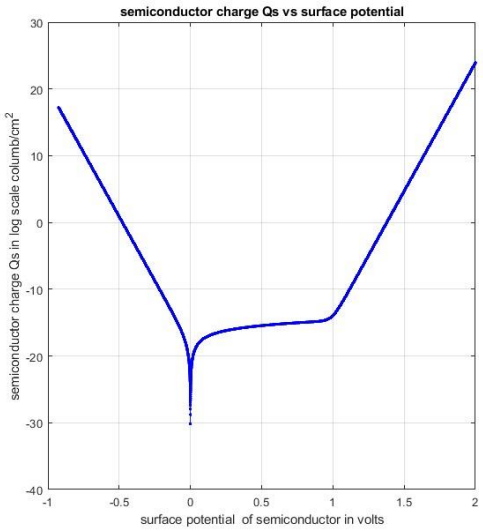
Ans no 1 A

```
'semiconductor charge vs surface potential

clc
clear
na=5*10^17;
tox=2*10^-7;
q=1.6*10^-19;
ep_si=106.2480*10^-14;
ep_ox=35.4160*10^-14;
c_ox=ep_ox/tox;
eg=1.1;
ki=4.05;
ni=1.5*10^10;
fi_m=4.04;
pi_f=0.026*log(na/ni);
fi_sc=ki+(eg/2)+pi_f;
fi_ms=fi_m-fi_sc;
Q_fix=2*10^-7;
%vt=(fi_ms-(Q_fix/c_ox)+(2*pi_f))+(((2*ep_si*q*na*2*pi_f)^0.5)/c_ox);
vt=0.026;
x1 =-0.925 :0.0001:0.001; % surface potential variation from -5*vt to 2 volts
y1=1*((2*ep_si*q*na)^0.5)*(((vt*exp(-x1/vt)+x1-vt)+(exp((-
2*pi_f)/vt)*((vt*exp(x1/vt))-x1-vt))));
x2 =0.001 :0.0001:2; % surface potential variation from -5*vt to 2 volts
y2=-1*((2*ep_si*q*na)^0.5)*(((vt*exp(-x2/vt)+x2-vt)+(exp((-
2*pi_f)/vt)*((vt*exp(x2/vt))-x2-vt))));
x=[x1,x2];
y=[y1,y2];
t = tiledlayout(1,2);
nexttile
plot(x2,y2,"Marker",".","Color",'b')
xlabel('surface potential phi_sin volts')
ylabel('semiconductor charge Qs in columb/cm^2')
title('semiconductor charge vs surface potential')
grid on
nexttile
plot(x,log(y),"Marker",".","Color",'b')
xlabel('surface potential  of semiconductor in volts')
ylabel('semiconductor charge Qs in log scale columb/cm^2')
title('semiconductor charge Qs vs surface potential')
grid on
```

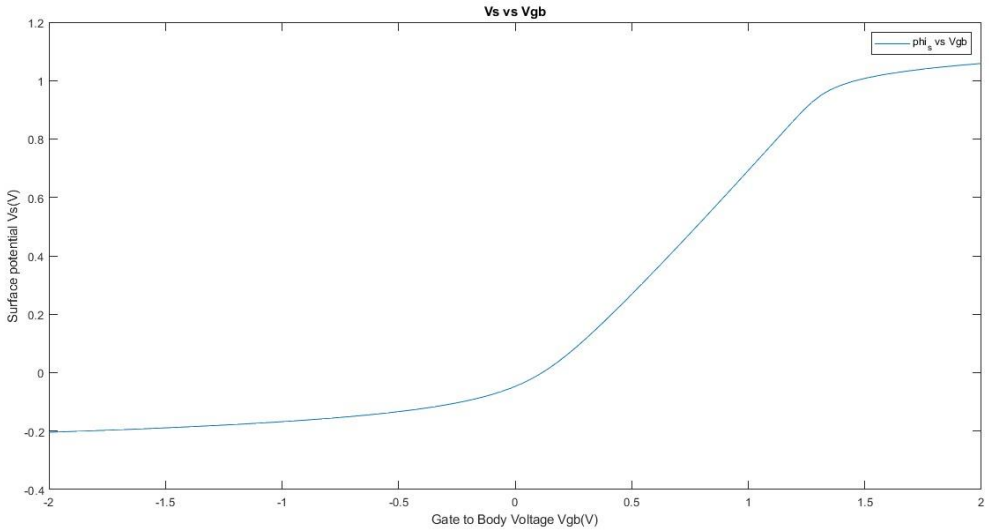




Ans no 1(b)

Vs vs Vgb:

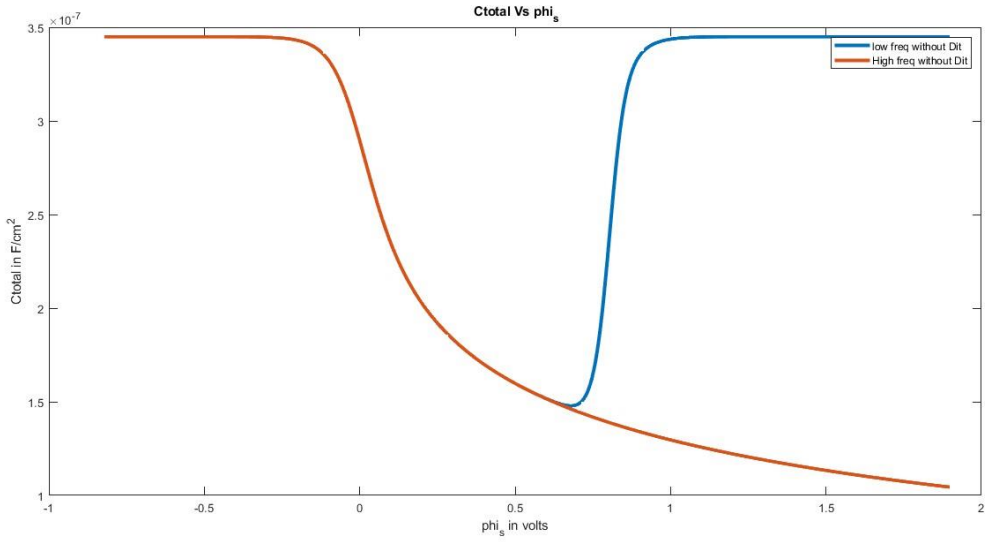
```
epsilon_s = 11.6*8.854187817*(10^(-14)); %F/cm

epsilon_ox = 3.9*8.854187817*(10^(-14)); %F/cm
q = 1.6*(10^(-19));     %C
Na = 5*(10^17);     %cm-3
ni = 1.5*(10^10); %cm-3
tox = 2*(10^(-7));  %cm
Qf = 2*(10^(-7)); %C/cm2
Cox = epsilon_ox/tox;  %F/cm2
Vfb = Qf/Cox;   %Volts
Vt = .026;     %threshold voltage(V)
k = (2*q*epsilon_s*Na)^(1/2); %constant
k1 = (Na/ni)^(-2);
Vcb = 0;
Vgb = linspace(-2, 2, 100);
for i=1:100
Vs0 = .1;
    func = @(Vs) (Vfb+ ((sign(Vs)).*(k.*((Vs-Vt+(Vt*exp(-Vs/Vt)))+  k1.*(-Vs-
(Vt*(exp(-Vcb/Vt)))+(Vt*exp((Vs-Vcb)/Vt)))).^(1/2)))/Cox + Vs -Vgb(i));
    z(1,i) = fzero(func,Vs0);
end
plot(Vgb,z)
xlabel("Gate to Body Voltage Vgb(V)");
ylabel("Surface potential Vs(V)");
title("Vs vs Vgb");
```



Ans no 2 a

```
clc ;
clear all;
close all;
Dit=1e12;
ep=1.05e-12; q=1.6e-19;
Na=5e17;
Phim=4.1;
ni=1.5*(10^10);
Eg=1.1;
Vt=0.026;
chi=4.05;
Phis=(chi+(Eg/2)+(Vt*log(Na/ni)));
Phi_ms=Phim-Phis;
Qf=2*10^(-7);
tox1 =2e-7 ;
eps_siO2 = 4*8.854*1e-14;
Cox=(eps_siO2/tox1);
Vfb=Phi_ms-(Qf/Cox);
Cox=0.345e-6;
phi_f=0.39;
phi_t=0.026;
a1=sqrt(2*ep*Na*q);
psi_s=-0.82:0.00001:1.9;
n=length(psi_s);
Cc1_prime=[];
Cch_prime=[];
y1=[];
y2=[];
Vgb=[];
Cgb_prime=[];
```

```
Cgbh_prime=[];
Qc1_prime=[];
for i=1:n
if Vgb==Vfb
Cgb_prime=sqrt(q*ep*Na/phi_t);
else
Qc_prime(1,i)=sign(psi_s(1,i))*a1*sqrt((phi_t*exp(-psi_s(1,i)/phi_t))+psi_s(1,i)-
phi_t+(exp(-2*phi_f/phi_t))*(phi_t*exp(psi_s(1,i)/phi_t)-psi_s(1,i)-phi_t));
y1(1,i)=2*sqrt((phi_t*exp(-psi_s(1,i)/phi_t))+psi_s(1,i)-phi_t+(exp(-
2*phi_f/phi_t))*(phi_t*exp(psi_s(1,i)/phi_t)-psi_s(1,i)-phi_t));
y2(1,i)=2*sqrt((phi_t*exp(-psi_s(1,i)/phi_t))+psi_s(1,i)-phi_t);
Cc1_prime(1,i)=sign(psi_s(1,i))*a1*((1-exp(-psi_s(1,i)/phi_t)+exp(-
2*phi_f/phi_t)*(exp(psi_s(1,i)/phi_t)-1))/y1(1,i));
Cc1h_prime(1,i)=sign(psi_s(1,i))*a1*((1-exp(-psi_s(1,i)/phi_t))/y2(1,i));
Vgb(1,i)=Vfb+psi_s(1,i)+(-sign(psi_s(1,i))*a1*sqrt((phi_t*exp(-
psi_s(1,i)/phi_t))+psi_s(1,i)-phi_t-(exp((-
2*phi_f)/phi_t))*(phi_t*exp(psi_s(1,i)/phi_t)-psi_s(1,i)-phi_t)));
Cgb_prime(1,i)=Cox*Cc1_prime(1,i)/(Cox+Cc1_prime(1,i));
Cgbh_prime(1,i)=Cox*Cc1h_prime(1,i)/(Cox+Cc1h_prime(1,i));
Qit_prime(1,i)=q*Dit*(phi_f-psi_s(1,i));
Cit=q*Dit;
Cgb1_prime(1,i)=Cox*(Cc1_prime(1,i)+Cit)/(Cit+Cox+Cc1_prime(1,i));
Vgb2(1,i)=Vfb+psi_s(1,i)-(Qit_prime(1,i)/Cox)+(-
sign(psi_s(1,i))*a1*sqrt((phi_t*exp(-psi_s(1,i)/phi_t))+psi_s(1,i)-phi_t-(exp((-
2*phi_f)/phi_t))*(phi_t*exp(psi_s(1,i)/phi_t)-psi_s(1,i)-phi_t)));
end
end
% Cgb' and Vgb'
plot(psi_s,Cgb_prime,psi_s,Cgbh_prime,psi_s,Cgb1_prime,psi_s,Cgbh_prime,'LineWidth
',3);
title(' Ctotal Vs Vgb');
xlabel('Vgb in volts ');
ylabel('Ctotal in F/cm^2');
% Cgb' and Vgb' With Dit HF and LF
plot(psi_s,Cgb_prime,psi_s,Cgbh_prime,'LineWidth',3);
title(' Ctotal Vs phi_s');
xlabel('phi_s in volts');
ylabel('Ctotal in F/cm^2');
legend('low freq without Dit','High freq without Dit','low freq withDit','High
freq with Dit');
```



Ans no 2(b)

Ctotal vs Vgb

```
clc ;
clear all;
close all;
Dit=1e12;
ep=1.05e-12; q=1.6e-19;
Na=5e17;
Phim=4.1;
ni=1.5*(10^10);
Eg=1.1;
Vt=0.026;
chi=4.05;
Phis=(chi+(Eg/2)+(Vt*log(Na/ni)));
Phi_ms=Phim-Phis;
Qf=2*10^(-7);
tox1 =2e-7 ;
eps_siO2 = 4*8.854*1e-14;
Cox=(eps_siO2/tox1);
Vfb=Phi_ms-(Qf/Cox);
Cox=0.345e-6;
phi_f=0.39;
phi_t=0.026;
a1=sqrt(2*ep*Na*q);
psi_s=-0.82:0.00001:1.9;
n=length(psi_s);
Cc1_prime=[];
Cch_prime=[];
y1=[];
y2=[];
Vgb=[];
Cgb_prime=[];
Cgbh_prime=[];
Qc1_prime=[];
for i=1:n
if Vgb==Vfb
Cgb_prime=sqrt(q*ep*Na/phi_t);
else
Qc_prime(1,i)=sign(psi_s(1,i))*a1*sqrt((phi_t*exp(-psi_s(1,i)/phi_t))+psi_s(1,i)-
phi_t+(exp(-2*phi_f/phi_t))*(phi_t*exp(psi_s(1,i)/phi_t)-psi_s(1,i)-phi_t));
y1(1,i)=2*sqrt((phi_t*exp(-psi_s(1,i)/phi_t))+psi_s(1,i)-phi_t+(exp(-
2*phi_f/phi_t))*(phi_t*exp(psi_s(1,i)/phi_t)-psi_s(1,i)-phi_t));
y2(1,i)=2*sqrt((phi_t*exp(-psi_s(1,i)/phi_t))+psi_s(1,i)-phi_t);
Cc1_prime(1,i)=sign(psi_s(1,i))*a1*((1-exp(-psi_s(1,i)/phi_t)+exp(-
2*phi_f/phi_t)*(exp(psi_s(1,i)/phi_t)-1))/y1(1,i));
Cc1h_prime(1,i)=sign(psi_s(1,i))*a1*((1-exp(-psi_s(1,i)/phi_t))/y2(1,i));
Vgb(1,i)=Vfb+psi_s(1,i)+(-sign(psi_s(1,i))*a1*sqrt((phi_t*exp(-
psi_s(1,i)/phi_t))+psi_s(1,i)-phi_t-(exp((-
2*phi_f)/phi_t))*(phi_t*exp(psi_s(1,i)/phi_t)-psi_s(1,i)-phi_t)));
Cgb_prime(1,i)=Cox*Cc1_prime(1,i)/(Cox+Cc1_prime(1,i));
```

```
Cgbh_prime(1,i)=Cox*Cc1h_prime(1,i)/(Cox+Cc1h_prime(1,i));
Qit_prime(1,i)=q*Dit*(phi_f-psi_s(1,i));
Cit=q*Dit;
Cgb1_prime(1,i)=Cox*(Cc1_prime(1,i)+Cit)/(Cit+Cox+Cc1_prime(1,i));
Vgb2(1,i)=Vfb+psi_s(1,i)-(Qit_prime(1,i)/Cox)+(-
sign(psi_s(1,i))*a1*sqrt((phi_t*exp(-psi_s(1,i)/phi_t))+psi_s(1,i)-phi_t-(exp((-
2*phi_f)/phi_t))*(phi_t*exp(psi_s(1,i)/phi_t)-psi_s(1,i)-phi_t)));
end
end
% Cgb' and Vgb'
plot(Vgb,Cgb_prime,Vgb,Cgbh_prime,Vgb2,Cgb1_prime,Vgb,Cgbh_prime,'LineWidth',3);
title(' Ctotal Vs Vgb');
xlabel('Vgb in volts ');
ylabel('Ctotal in F/cm^2');
% Cgb' and Vgb' With Dit HF and LF
plot(Vgb,Cgb_prime,Vgb,Cgbh_prime,'LineWidth',3);
title(' Ctotal Vs Vgb');
xlabel('Vgb in volts');
ylabel('Ctotal in F/cm^2');
legend('low freq without Dit','High freq without Dit','low freq withDit','High
freq with Dit');
```