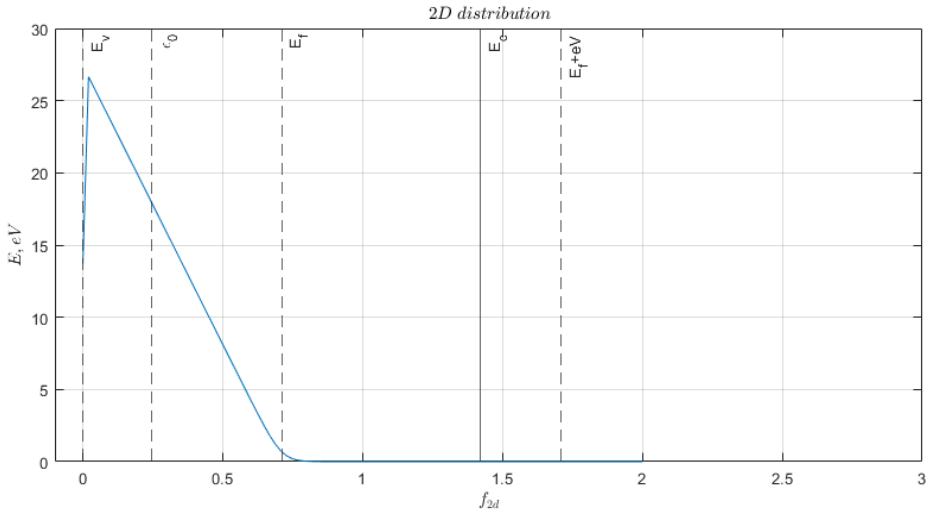
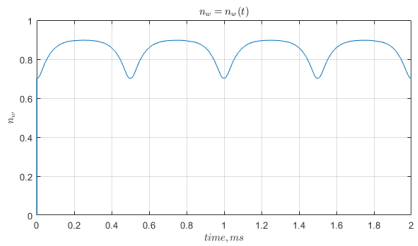
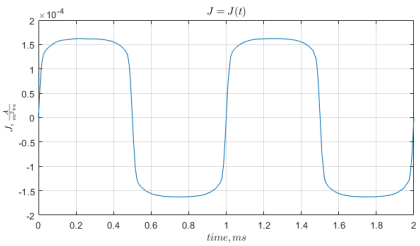
```
%preparing workspace
clc
clear
close all

%constants
k=1.38e-23;
hbar=1.0546e-34;
m0=9.1e-31;
e=1.6e-19;

%initial paramets
T=300;                  %room temperature, K
a=3e-9;                 %size of chanel, 3nm
b=2e-9;                 %size of barrier, 2nm
U0=1*e;                 %height of barrier, 1 eV
m=0.067*m0;             %eff. mass in GaAs, kg
mb=(0.067+0.083*0.5)*m0;%eff. mass in AlGaAs(0.5), kg
n=1e23;
% Ef=(hbar^3*3*pi^2*n)^(2/3)/(2*m);
% Ef=Ef-pi^2/12*(k*T)^2/Ef+7*pi^4/360*(k*T)^4/Ef^3;
% Ef/e
Ef=0.71*e;              %Fermi energy, eV (at T=300)(0,14)
Eg=1.42*e;              %gap energy, eV
v=1e6;                  %frequency, 1Mhz
Ez=0.623*e;            %connection energy
V=@(t)sin(2*pi*v*t);    %periodic voltage, V

% t=linspace(0,2)*1e-6;   %time, 0-2 mcs
% V=V(0.359e-6);

% syms Nw(t) V(t) hbar m b e Ef Ez v k T eps

eps0=0.244*e;
eps=@(nw,t)eps0-e*V(t)/2+Ez*nw;%

Eks=@(nw,t)eps(nw,t);          %
Ekd=@(nw,t)eps(nw,t)+e*V(t);   %
Ekw=@(nw,t)eps0;               %

wsw=@(nw,t)sqrt(2*Eks(nw,t)/m)/b;
wdw=@(nw,t)sqrt(2*Ekd(nw,t)/m)/b;
wws=@(nw,t)sqrt(2*Ekw(nw,t)/m)/b;
wwd=@(nw,t)wws(nw,t);

%f2d=@(EF,E) m*k*T/(2*pi*hbar^2)*log(1+exp(-(E-EF)/
(k*T))).*heaviside(E-Eg);
f2d=@(EF,E,E0) log(1+exp(-(E-EF)/(k*T))).*heaviside(E-E0);
%f2d=@(EF,E) 1./(1+exp((E-EF)/(k*T))).*heaviside(E-Eg);


E=linspace(0,2)*e;
```

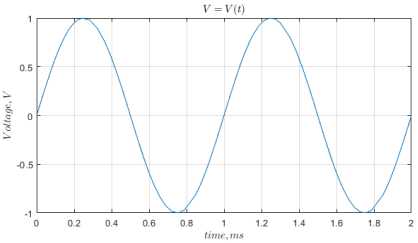
```
figure('Units','normalized','OuterPosition',[.2 .2 .6 .6])
plot(E/e,f2d(Ef,E,0))
xline(Eg/e,'-','E_c')
xline(Ef/e,'--','E_f')
xline(0/e,'--','E_v')
xline(Ef/e-1,'--','E_f-eV')
xline(Ef/e+1,'--','E_f+eV')
xline(eps0/e, '--','\epsilon_0')
grid on
ylabel('$E,eV$','Interpreter','latex')
xlabel('$f_{2d}$','Interpreter','latex')
title('$2D$ $distribution$','Interpreter','latex')
xlim([-0.1, 3])
% close all

Efs=Ef;
Efd=@(t)Ef-e*(V(t));

ns=@(nw,t)f2d(Efs,eps(nw,t),0);       %
nd=@(nw,t)f2d(Efd(t),eps(nw,t),-e*(V(t)));    %
% ns=@(nw,t)1;  %
% nd=@(nw,t)0;


jsw=@(nw,t)wsw(nw,t).*ns(nw,t).*(1-nw);
jdw=@(nw,t)wdw(nw,t).*nd(nw,t).*(1-nw);
jws=@(nw,t)wws(nw,t).*nw;
jwd=@(nw,t)wwd(nw,t).*nw;


eq = @(nw,t)jsw(nw,t)+jdw(nw,t)-jws(nw,t)-jwd(nw,t);
Nw0=0;
[t,Nw]=ode15s(@(t,nw)eq(nw,t),[0 2e-6],Nw0);

J=jsw(Nw,t)-jdw(Nw,t)-jws(Nw,t)+jwd(Nw,t);
V=V(t);

figure('Units','normalized','OuterPosition',[0 0 1 1])
subplot(2,2,1)
plot(t*1e6,Nw)
grid on
xlabel('$time,ms$','Interpreter','latex')
ylabel('$n_w$','Interpreter','latex')
title('$n_w=n_w(t)$','Interpreter','latex')

subplot(2,2,2)
plot(t*1e6,J*e)
grid on
xlabel('$time,ms$','Interpreter','latex')
ylabel('$J,{A \over m^2*s}$','Interpreter','latex')
title('$J=J(t)$','Interpreter','latex')

subplot(2,2,3)
plot(t*1e6,V)
```

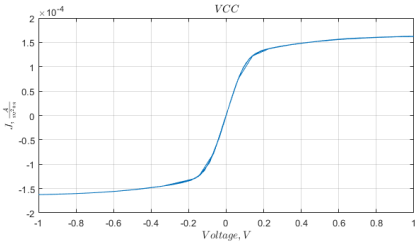
```
grid on
xlabel('$time,ms$','Interpreter','latex')
ylabel('$Voltage,V$','Interpreter','latex')
title('$V=V(t)$','Interpreter','latex')

subplot(2,2,4)
plot(V,J*e)
grid on
ylabel('$J,{A \over m^2*s}$','Interpreter','latex')
xlabel('$Voltage,V$','Interpreter','latex')
title('$VCC$','Interpreter','latex')
% xlim([0 inf])
% ylim([0 inf])
```











Published with MATLAB® R2020b