```
clc;
clear variables;
close all;

% Constants
hbar=6.582119*10^-16; %[eV*s]
hbarJ=1.0545718*10^-34; %[J*s]
kb=8.6173303*10^-5; %[eV/K]
kbJ=1.38064852*10^-23; %[J/K]
T=300; %[K]
ep0=8.854187817*10^-12; %[F/m]
e=1.6021766208*10^-19; %[C]
m0=9.10938356*10^-31; %[kg]

Ec=0;

% GaAs
effm = 0.067*m0; %[kg] for gamma, L, X respectively
rho = 5.36/1000*(100^3); %[kg/m^3]
vs = 5.24*10^5/100; %[m/s]
epr0 = 12.90;
eprInf = 10.92;

nE=50;
E=linspace(0.000001,2,nE);

% Acoustic Phonon Scattering
Dac = 7.01; %[eV] for gamma, L, X respectively

% Polar Optical Phonon Scattering
E0 = 0.03536; %[eV]
w0 = E0/hbar; % [1/s]
N0=(exp(E0/(kb*T))-1)^(-1);

% Ionized Impurity Scattering
dNI = 100;
NI = logspace(20,25,dNI); % [1/m^3]
Z = 1;

GammaMAcoustic(1:nE)=0;
GammaMIonImp(1:nE,1:length(NI))=0;
GammaPop(1:nE)=0;
GammaTot(1:nE,1:length(NI))=0;

k(1:nE)=0;

% Calculation Loop

for i=1:nE

    k(i) = sqrt(2*effm*E(i)/(hbar*hbarJ));

% Density of States
g3dAcoustic = sqrt(2)/(pi^2*hbar^3)*effm^(3/2)*sqrt(E(i)-Ec);
```

```matlab
% Acoustic Phonon Scattering
GammaMAcoustic(i) = 2*pi/(hbarJ*hbar)^(1/2)*Dac^2*kb*T/(2*rho*vs^2)*g3dAcoustic;

% Polar Optical Phonon Scattering
PopFactor=sqrt(hbar/hbarJ)*e^2*w0/(8*pi)*sqrt(2*effm(1)/hbarJ^2)*(1/(ep0*eprInf)-1/(ep0*epr0))
*1/sqrt(E(i));
ScattPolarOpAbs = PopFactor*N0*log(abs((1+sqrt(1+E0/E(i)))/(-1+sqrt(1+E0/E(i)))));
ScattPolarOpEmi = PopFactor*(N0+1)*log(abs((1+sqrt(1-E0/E(i)))/(1-sqrt(1-E0/E(i)))))*heaviside
(E(i)-E0);
GammaPop(i) = ScattPolarOpAbs + ScattPolarOpEmi;

for m=1:length(NI)

% Ionized Impurity Scattering
Ld=sqrt(ep0*eprInf*kbJ*T/(e^2*NI(m))); %[m]
gamma=sqrt(8*effm*E(i)*Ld^2/(hbar*hbarJ));
GammaMIonImp(i,m)=(hbar/hbarJ)^(3/2)*(NI(m)*e^4)/(16*sqrt(2*effm(1))*pi*eprInf^2*ep0^2)*(log(1
+gamma^2)-gamma^2/(1+gamma^2))*E(i)^(-3/2);

GammaTot(i,m) = GammaMAcoustic(i)+GammaMIonImp(i,m)+GammaPop(i);
end

end

g0(1:nE,1:length(NI))=0;
v(:) = hbarJ*k(:)/effm; %[m/s]

for i=1:nE
g0(i,:) = e.*v(i).*(-1/(kbJ*T))*exp(-E(i)/(kb*T))./GammaTot(i,:);
end

g=g0;
Ipop(1:length(k),1:length(NI))=0;

% start loop
threshold=1e-7;

ksi1 = sqrt(1-E0./E);
ksi2 = sqrt(1+E0./E);

for m=1:length(NI)
  for i=2:nE-1
      deltag=1;
    while deltag>threshold
        % Update g until convergence
        gammaksi1 = g(i-1,m)*(-1+(2+ksi1(i)^2)/(2*ksi1(i))*log(abs((1+ksi1(i))/(1-ksi1(i)))));
        gammaksi2 = g(i+1,m)*(-1+(2+ksi2(i)^2)/(2*ksi2(i))*log(abs((1+ksi2(i))/(1-ksi2(i)))));
        Ipop(i,m)=(e^2*(w0*e)*effm)/(4*pi*ep0*hbarJ^2*k(i))*(1/eprInf-1/epr0)*(N0*heaviside(ks
i1(i)^2)*gammaksi1+(N0+1)*gammaksi2);
        if E(i)>E0
        gtemp = g(i,m);
        g(i,m)=gtemp + Ipop(i,m)/GammaTot(i,m);
        deltag = abs(g(i,m)-gtemp);
        end
    end
  end
end
```

```
% Integrate

mobility(1:length(NI))=0;


for m=1:length(NI)
    top=0;
    bottom=0;
    for i=1:nE
    % Numerical Integration for Mobility
    top=top+e*E(i)*g(i,m);
    bottom=bottom+exp(-E(i)/(kb*T))*sqrt(e*E(i));
    mobility(m)=-sqrt(2/effm)*top/(3*bottom);
    end
end

figure(1)
loglog(NI/(100)^3,mobility*100^2)
grid on
title('Mobility vs N_D')
xlabel('N_D (1/cm^{3})')
ylabel('\mu (cm^{2}/(Vs)')
axis([1e14 1e19 1e2 2e4])
```