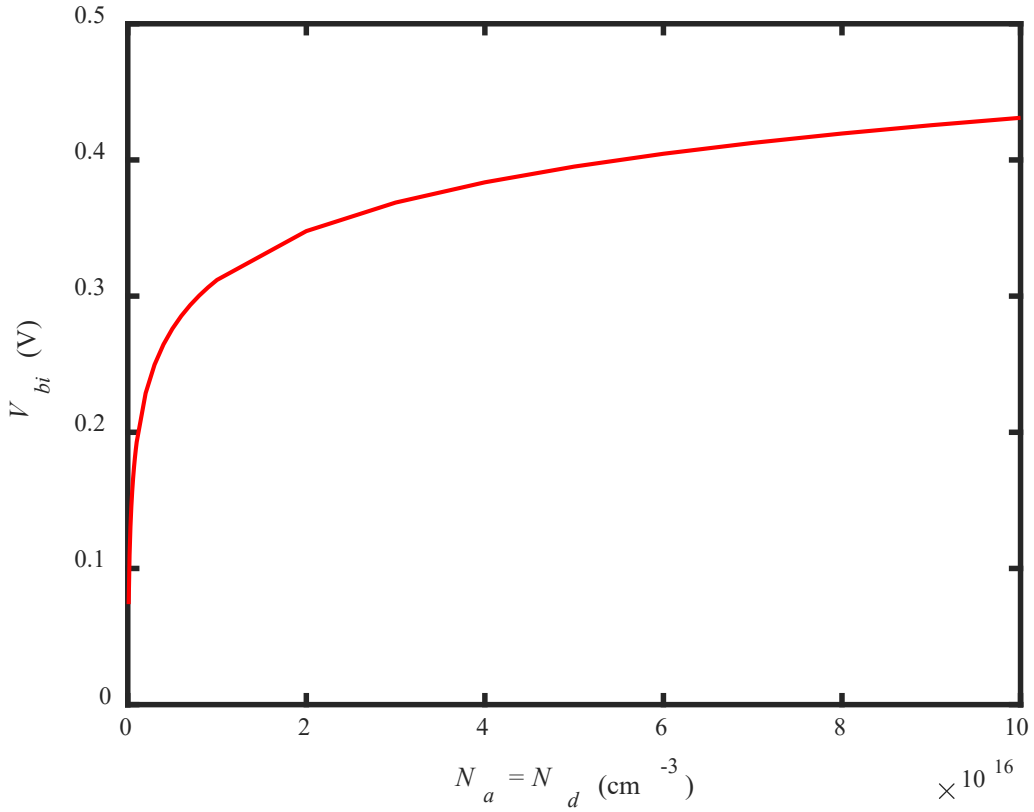
7.3 (*a*) Plot the built-in potential barrier for a symmetrical ($N_a = N_d$) silicon pn junction at $T = 300$ K over the range $10^{14} \le N_a = N_d \le 10^{17}$ cm^{-3}.

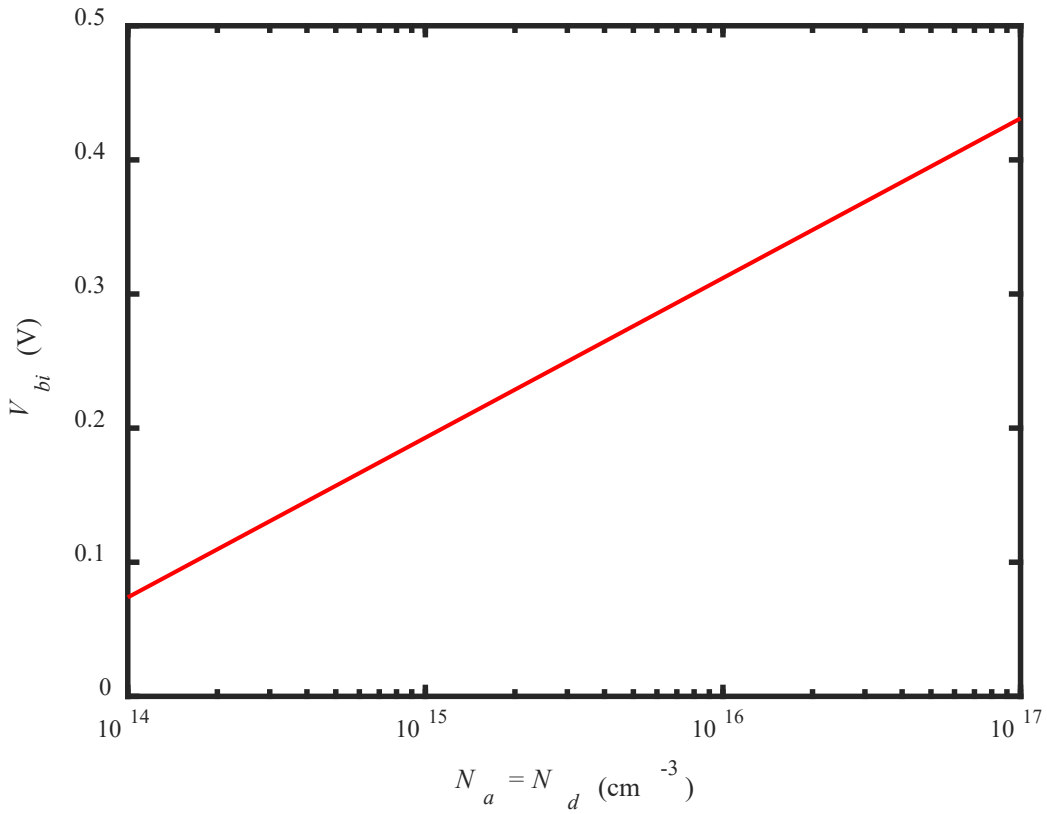
➢ for a germanium (Ge) pn junction. Do both linear and semilog plots using Matlab. Include m-file.

From Table B.4, $n_i = 2.4 \times 10^{13}$ cm^{-3} for Ge at 300 K.

m-file

```
% EE 362 problem 7.3a(p7_03a_Ge.m)
% Plot Vbi for Na = Nd from 10^14 to 10^17 cm^-3
clear; clc; close all;
kB = 1.380649e-23; % Boltzmann constant (J/K)
T = 300; % temperature (K)
qe = 1.602176634e-19; % magnitude of electron charge (C)
ni = 2.4e13;   % n_i (cm^-3) for Ge at 300 K
Vt = kB*T/qe;  % thermal voltage (V)
n = 1:9; N1 = 1e14*n; N2 = 1e15*n; N3 = 1e16*n;
N = [N1, N2, N3, 1e17];
Vbi = Vt*log(N.*N/ni^2);
% ******* Plot Vbi in linear format *******
plot(N,Vbi,'r-')
axis([0 1e17 0 0.5]);
xlabel('{\it N_a = N_d}  (cm^{-3})','fontsize',14,'fontname','times'),
ylabel('{\it V_{bi}}  (V)','fontsize',14,'fontname','times'),
% ******* Plot Vbi in semilog format *******
figure; semilogx(N,Vbi,'r-');
axis([1e14 1e17 0 0.5]);
xlabel('{\it N_a = N_d}  (cm^{-3})','fontsize',14,'fontname','times'),
ylabel('{\it V_{bi}}  (V)','fontsize',14,'fontname','times'),
set(findobj('type','axes'),'fontsize',12,'fontname','times')
set(findobj('type','line'),'linewidth',1.5)
set(findobj('type','axes'),'linewidth',2)
```


0.5
0.4
0.3
0.2
0.1
0
V_{bi} (V)
0
2
4
6
8
10
$N_a = N_d$ (cm $^{-3}$)
$\times 10^{16}$


0.5
0.4
0.3
0.2
0.1
0
V_{bi} (V)
10^{14}
10^{15}
10^{16}
10^{17}
$N_a = N_d$ (cm $^{-3}$)