EECS 170A
Professor Burke Section B
Homework #5 Solutions and Grading Criteria

1) $I_{AD} = I_0(e^{qVdiode/kT} - 1)$
$I_{AD} = (V_{AD} - V_{diode}) / 2k\Omega$ *(Using Ohm's Law)*
2 Equations, 2 unknowns since I_0 and V_{AD} are given.

V_{AD} (V)	V_{diode} (V)	Acceptable Range for V_{diode}	I_{AD} (mA)	Acceptable Range for I_{AD}
0	*0*	*0*	*0*	*0*
0.5	*0.496*	*0.48 - 0.51*	*0.002*	*0.001 - 0.003*
1	*0.613*	*0.59 - 0.62*	*0.193*	*0.1 - 0.3*
1.5	*0.634*	*0.62 - 0.64*	*0.433*	*0.3 - 0.5*
2	*0.646*	*0.63 - 0.65*	*0.677*	*.05 - 0.7*
2.5	*0.654*	*0.64 - 0.66*	*0.923*	*0.8 – 1*
3	*0.660*	*0.65 - 0.67*	*1.17*	*1 - 1.2*
3.5	*0.665*	*0.65 - 0.67*	*1.42*	*1.3 - 1.5*
4	*0.669*	*0.65 - 0.67*	*1.67*	*1.5 - 1.7*
4.5	*0.673*	*0.66 - 0.68*	*1.91*	*1.8 - 2*
5	*0.676*	*0.66 - 0.68*	*2.16*	*2 - 2.2*
5.5	*0.679*	*0.66 - 0.68*	*2.41*	*2.3 - 2.5*
6	*0.681*	*0.67 - 0.69*	*2.66*	*2.5 - 2.7*
6.5	*0.684*	*0.67 - 0.69*	*2.91*	*2.8 - 3*
7	*0.686*	*0.67 - 0.69*	*3.16*	*3 - 3.2*
7.5	*0.688*	*0.67 - 0.69*	*3.41*	*3.3 - 3.5*
8	*0.690*	*0.68 - 0.7*	*3.66*	*3.5 - 3.7*
8.5	*0.691*	*0.68 - 0.7*	*3.90*	*3.8 - 4*
9	*0.693*	*0.68 - 0.7*	*4.15*	*4 - 4.2*
9.5	*0.694*	*0.68 - 0.7*	*4.40*	*4.3 - 4.5*
10	*0.696*	*0.68 - 0.7*	*4.65*	*4.5 - 4.7*

Grading: 1 pt for each answer in table.

2) Using the 1kΩ base resistance:
a) $V_{EB} = V_E - V_B = 0.6$ *(Make sure you get this sign right. Depends on pnp or npn)*
b) $I_C = \beta I_B = 100\, I_B$
c) $I_E = I_B + I_C = 101 I_B$
d) $I_C = (V_C + 7) / 2000$
e) $I_B = (V_B + 3) / 1000$
f) $I_E = -V_E / 2000$

c = f: $101 I_B = -V_E / 2000$
e: $101(V_B + 3) / 1000 = -V_E / 2000$
$-202(V_B + 3) = V_E$
a: $V_E = V_B + 0.6$
$-202(V_B + 3) = V_B + 0.6$
$V_B = -2.99V$
$V_E = V_B + 0.6 = -2.39V$

e: $I_B = (V_B + 3) / 1000 = 11.8\mu A$
b: $I_C = 100\ I_B = 1.18mA$
c: $I_E = 101\ I_B = 1.19mA$
d: $I_C = (V_C + 7) / 2000$
$V_C = 2000I_C - 7 = -4.64V$
$V_{BE} = V_B - V_E = -0.6V$
$V_{CE} = V_C - V_E = -2.25V$
$V_{BC} = V_B - V_C = 1.65V$
Since $V_{BE} < 0$ and $V_{BC} > 0$, the pnp BJT is in active mode.

V_B	*-2.99V*	*6 pts (no partial credit)*
V_C	*-4.64V*	*6 pts (no partial credit)*
V_E	*-2.39V*	*6 pts (no partial credit)*
V_{BE}	*-0.6V*	*6 pts (no partial credit)*
V_{CE}	*-2.25V*	*6 pts (no partial credit)*
V_{BC}	*1.65V*	*6 pts (no partial credit)*
I_B	*11.8μA*	*6 pts (no partial credit)*
I_C	*1.18mA*	*6 pts (no partial credit)*
I_E	*1.19mA*	*6 pts (no partial credit)*
Active? Y or N	*Yes*	*4 pts (no reason needed)*

If a 1Ω base resistance is used, the following answers are calculated:
Equations a-d and f are the same.
e) $I_B = V_B + 3$
e: $101(V_B + 3) = -V_E / 2000$
$-202000(V_B + 3) = V_E$
$-202000(V_B + 3) = V_B + 0.6$
$V_B = -3.00V$
$V_E = V_B + 0.6 = -2.40V$
e: $I_B = V_B + 3 = 11.9\mu A$
b: $I_C = 100\ I_B = 1.19mA$
c: $I_E = 101\ I_B = 1.20mA$
$V_C = 2000I_C - 7 = -4.62V$
$V_{BE} = V_B - V_E = -0.6V$
$V_{CE} = V_C - V_E = -2.22V$
$V_{BC} = V_B - V_C = 1.62V$
Since $V_{BE} < 0$ and $V_{BC} > 0$, the pnp BJT is in active mode.

V_B	*-3.00V*	*6 pts (no partial credit)*
V_C	*-4.62V*	*6 pts (no partial credit)*
V_E	*-2.40V*	*6 pts (no partial credit)*
V_{BE}	*-0.6V*	*6 pts (no partial credit)*
V_{CE}	*-2.22V*	*6 pts (no partial credit)*
V_{BC}	*1.62V*	*6 pts (no partial credit)*
I_B	*11.9μA*	*6 pts (no partial credit)*
I_C	*1.19mA*	*6 pts (no partial credit)*
I_E	*1.20mA*	*6 pts (no partial credit)*
Active? Y or N	*Yes*	*4 pts (no reason needed)*