

ECE113A
Professor Burke (15400) Section A
Homework #6 Solutions and Grading Criteria

1) $\eta = 0.9$, $I_0 = 10^{-14} \text{A}$
 $I_{AB} = I_0(\exp[\eta q V_{\text{diode}}/kT] - 1)$
 $I_{AB} = (V_{AB} - V_{\text{diode}})/1\text{k}\Omega$ (Using Ohm's Law)

$V_{AB}(\text{V})$	$V_{\text{diode}}(\text{V})$	Acceptable Range for $V_{\text{diode}}(\text{V})$	$I_{AB}(\text{mA})$	Acceptable Range for $I_{AB}(\text{mA})$
0	0	0	0	0
0.5	0.4997	.49-.51	3.47×10^{-4}	$3.00 \times 10^{-4} - 4.00 \times 10^{-4}$
1	0.6947	.68-.70	.305	.21-.41
1.5	0.7217	.71-.73	.778	.678-.878
2	0.7356	.73-.75	1.26	1.16-1.36
2.5	0.7451	.74-.76	1.75	1.65-1.85
3	0.7522	.74-.76	2.25	2.15-2.35
3.5	0.7579	.75-.77	2.74	2.64-2.85
4	0.7627	.75-.77	3.23	3.13-3.33
4.5	0.7668	.76-.78	3.73	3.63-3.83
5	0.7704	.76-.78	4.23	4.13-4.33
5.5	0.7736	.76-.78	4.73	4.63-4.83
6	0.7765	.77-.79	5.22	5.12-5.32
6.5	0.7791	.77-.79	5.72	5.62-5.82
7	0.7815	.77-.79	6.22	6.12-6.32
7.5	0.7837	.77-.79	6.72	6.62-6.82
8	0.7858	.78-.80	7.21	7.11-7.31
8.5	0.7877	.78-.80	7.71	7.61-7.81
9	0.7895	.78-.80	8.21	8.11-8.31
9.5	0.7912	.78-.80	8.71	8.61-8.81
10	0.7928	.78-.80	9.21	9.11-9.31

Grading: 1 pt for each answer in the table.

- 2) a. $I_C = \beta I_B = 100 I_B$
b. $I_E = I_B + I_C = (1 + \beta) I_B = 101 I_B$
c. $V_{BE} = V_B - V_E = 0.6\text{V}$
d. $I_C = (10\text{V} - V_C)/1000\Omega$ (Ohm's Law)
e. $I_E = (V_E - 0\text{V})/1000\Omega$ (Ohm's Law)
f. $I_B = (5\text{V} - V_B)/1000\Omega$ (Ohm's Law)

a = d: $100 I_B = (10\text{V} - V_C)/1000\Omega$

$I_B = (10\text{V} - V_C)/100,000\Omega$

b = e: $101 I_B = V_E/1000\Omega$

$$V_E = 101,000I_B = 101,000(10V - V_C)/100,000 = 1.01(10V - V_C)$$

f: $(5V - V_B)/1000\Omega = (10V - V_C)/100,000\Omega$
 $5 - V_B = (10V - V_C)/100$
 $V_B = 5V - (10V - V_C)/100$

c: $5V - (10V - V_C)/100 - 1.01(10V - V_C) = 0.6$
 $(5 - .1 - 10.1 - 0.6)V + (.01 + 1.01)V_C = 0$
 $-5.8 + 1.02V_C = 0$
 $V_C = 5.8/1.02 = 5.69V$
 $V_B = 5V - (10V - V_C)/100 = 5V - (10V - 5.69V)/100 = 4.96V$
 $V_E = 1.01(10V - V_C) = 1.01(10V - 5.69V) = 4.36V$

f: $I_B = (5V - V_B)/1000\Omega = (5V - 4.96V)/1000\Omega = 43.1\mu A$

a: $I_C = 100I_B = 100(43.1\mu A) = 4.31mA$

b: $I_E = 101I_B = 101(43.1\mu A) = 4.36mA$

V_B	$4.96V$ (4.5-5.5V)	6 pts (no partial credit)
V_C	$5.69V$ (5-6V)	6 pts (no partial credit)
V_E	$4.36V$ (4-5V)	6 pts (no partial credit)
V_{BE}	$0.6V$	6 pts (no partial credit)
V_{BC}	$-0.73V$ (-0.5-(-1)V)	6 pts (no partial credit)
V_{CE}	$1.33V$ (1-2V)	6 pts (no partial credit)
I_B	$43.1\mu A$ (42-44 μA)	6 pts (no partial credit)
I_C	$4.31mA$ (4-5mA)	6 pts (no partial credit)
I_E	$4.36mA$ (4-5mA)	6 pts (no partial credit)
Active?	<i>Yes</i> ($V_{BE} > 0$ & $V_{BC} < 0$)	4 pts (No reason needed for credit)