EE 115A

Midterm Exam
Fall 2002

Your Name:

Name of Person to Your Left: __________________________
Name of Person to Your Right: ________________________

Closed Book. One sheet of notes allowed.
Each problem is worth 3 points.
Do not guess. Each wrong answer receives — 1 point.

1. ____________________________ 6. ____________________________
2. ____________________________ 7. ____________________________
3. ____________________________ 8. ____________________________
4. ____________________________ 9. ____________________________
5. ____________________________ 10. ____________________________

Total: ____________________________
1. Sketch $I_1$ versus $V_1$. Diodes are ideal.

![Diagram](image)

2. Sketch the current through $D_1$ versus $V_1$. Diodes are ideal.

![Diagram](image)
3. Sketch $V_{\text{out}}$ versus $V_{\text{in}}$. Use the constant-voltage (0.8-V) diode model.

![Diode Circuit Diagram]

4. What is the small-signal voltage gain of this circuit ($\beta \gg 1, V_A = \infty$)?

- (a) $\frac{2R_B}{\beta + 1} + \frac{1}{g_{m2}} - \frac{1}{g_{m1}}$
- (b) $\frac{R_B}{R_E} + \frac{1}{g_{m2}} - \frac{1}{g_{m1}}$
- (c) $\frac{r_{\pi 2} + 2R_B}{R_E} + \frac{1}{g_{m1}}$
- (d) $\frac{r_{\pi 2} + 2R_B}{\beta + 1} - \frac{1}{g_{m1}}$
5. What is the input resistance of this circuit ($\beta < \infty$, $V_A = \infty$)?

(a) $R_F||(r_n+R_E)$  
(b) $R_F|[r_n+(\beta+1)R_E]$  
(c) $(\beta R_F)||[r_n+(\beta+1)R_E]$  
(d) $(\beta R_F)||[r_n+R_E]$ 

6. Which statement is true for this circuit ($V_{BE} \approx 0.8$ V, $\beta = 100$):

(a) $I_{C1} \approx 0.5$ mA.
(b) $I_{C1} \approx 1$ mA.
(c) $I_{C1} \approx 2$ mA.
(d) $Q_1$ is in saturation.
7. What is the output resistance of this circuit \(1 \ll \beta < \infty, V_A = \infty\)?

\[
\begin{align*}
(a) R_E \parallel & \frac{R_1 + R_2}{\beta + 1} \parallel \frac{1}{g_m} \\
(b) R_E \parallel & \frac{R_2}{\beta + 1} \parallel \frac{1}{g_m} \\
(c) R_E \parallel & \frac{1}{g_m} \\
(d) R_E \parallel & \frac{1}{r_\pi}
\end{align*}
\]

8. What is the voltage gain of this circuit \(\beta \gg 1, V_A = \infty\)?

\[
\begin{align*}
(a) \frac{R_C || (R_2 + r_\pi)}{2R_1 + \frac{1}{g_m}} \\
(b) \frac{R_C || R_2}{2R_1 + \frac{1}{g_m}} \\
(c) \frac{R_C || R_2}{2R_1 + \frac{R_2}{\beta + 1} + \frac{1}{g_m}} \\
(c) \frac{R_C || R_2}{2R_1 + r_\pi}
\end{align*}
\]
9. If $\beta \gg 1$ and $V_{BE} = 0.8$ V, what value of $V_{in}$ places $Q_1$ at the edge of saturation?
(a) +0.6 V
(b) +0.2 V
(c) -0.6 V
(d) -0.8 V

10. A transistor operating in the active mode has a $\beta$ of 100 and a base-emitter voltage of 0.8 V. Which statement is true for the following circuit?
(a) $Q_1$ is in saturation.
(b) $V_X = 2.3$ V
(c) $I_{C1} = 0$
(d) $R_C$ carries no current.