1. In the circuit below assume the diodes are ideal; i.e., 0.7V when turned on.
   a) Sketch $V_o$ vs. $V_1$ for $V_1$ ranging between -15 and +15 volts.
   b) Determine and label the slopes of all segments.
   c) Determine and label the values of $V_o$ & $V_i$ at points where the slope changes and where
      the slope is flat.

   \[ -9.7 = \frac{2}{3} \times V_1 \]
   \[ V_1 = -14.55 \]

   \[ 6.7 = \frac{5}{6} \times V_1 \]
   \[ V_1 = 8.04 \]

   \[ V_o = 6.7 \times 4/5 = 5.36 \]

   D1 turn on
   \[ V_i \]
   \[ V_o \]

   D2 turn on
   \[ V_i \]
   \[ V_o \]

   Slopes
   \[ V_i \text{ less than } -9.7 \]
   \[ V_i \text{ greater than } 6.7 \]
   \[ V_i \text{ in-between} \]
$V_o = 5.36$
$V_i = 8.04$

$V_o = -9.7$
$V_i = -14.55$

Slope = $\frac{2}{3}$
2. Analyze the circuit. \( \beta = 173 \) and \( V_{BE} = 0.7 \text{v} \).

Do NOT neglect the base current when doing the calculations.

a) \( I_B \)

b) \( I_E \)

c) \( I_C \)

d) \( V_{CE} \)

\[
\begin{align*}
V_B &= 15 \times 40K/15K = 4.091 \\
R_B &= 40K/15K = 10.91K \\
I_B &= (V_B - 0.7)/(R_B + R_3 + \beta R_e) = 3.391/127.9K = 0.0265 \text{mA} \\
I_E &= (1 + \beta)I_B = 4.6128 \text{mA} \\
I_C &= \beta I_B = 4.586 \text{mA} \\
V_{CE} &= 20 - I_C R_C - I_E R_E = 20 - 9.173 - 2.306 = 3.521
\end{align*}
\]
3. An AC analysis of this amplifier and compute input and output impedances. Use the small-signal model of the transistor and appropriate models of the capacitors and DC supply.

\[ \beta = 45, \quad r_o = \infty, \quad r_e = 10 \text{ ohms} \]

a) Compute \( Z_{it} = V_b/it \) (voltages and currents are AC)
b) Compute \( Z_x = V_x/ix. \)
c) Compute \( Z_s = V_s/is. \)
d) Compute \( Z_{ot} = V_c/iot \) (iot, would be produced if a AC test voltage, \( V_o \), was connected to the circuit; note that \( V_c = V_o \)).
e) Compute \( Z_o = V_o/io \)....(io, would be produced if a AC test voltage, \( V_o \), was connected to the circuit).

\[
\begin{align*}
Z_{it} &= (1+B)(r_e + RE1) = 2.25K \\
R_1//R_2 &= 10K \\
Z_x &= R_1//R_2//(Z_{it}+Rs2) = 2.17 \\
Z_{it}+Rs2 &= 2.75K \\
Z_x &= 2.136K \\
Z_s &= Rs + Z_x = 2.387K
\end{align*}
\]
<table>
<thead>
<tr>
<th>Symbol</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zit</td>
<td>2.25</td>
</tr>
<tr>
<td>Zs2</td>
<td>2.75</td>
</tr>
<tr>
<td>R1//R2</td>
<td>10</td>
</tr>
<tr>
<td>R1//R2//Zs2</td>
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<tr>
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<tr>
<td>Zot</td>
<td>2.2</td>
</tr>
<tr>
<td>Zo</td>
<td>2.049689</td>
</tr>
</tbody>
</table>
4. Graph solution for J-FET circuit.
   a) Write the loop-current equation involving $V_G$, $V_{GS}$, $V_1$, and $V_{RS}$.
   b) Plot $I_D$ vs. $V_{GS}$ on the 1\textsuperscript{st} graph.
   c) Find and label on the 1\textsuperscript{st} graph;
      1) $I_{DQ}$.
      2) $V_{GSQ}$
   d) Write the loop-current equation involving $V_{DD}$, $V_{DS}$, $V_1$, and $V_{RD}$ and $V_{RS}$.
   e) Plot $I_D$ vs. $V_{DS}$ on the 2\textsuperscript{nd} graph.
   f) Find and label $V_{DSQ}$ on the 2\textsuperscript{nd} graph.

\[
\begin{align*}
VG &= 20 \times 0.6 / 2.4 = 5 & \text{5each} \\
V_{GS} &= 5 - 1 - ID \times RS \\
ID \text{ at } V_{GS} = 0 \text{ is equal to } 4/2K = 2mA \\
V_{DS} &= 20 - 1 - ID(RD + RS) \\
ID \text{ at } V_{DS} = 0 \text{ is equal to } 20/3K = 6.67 \text{ mA}
\end{align*}
\]
\[ V_{GS} \]

\[ V_{DS} \]

- Gate-Source Voltage (volts)
- Drain-Source Voltage (volts)
- Drain Current (mA)

\[ I_D \]
Scores
1. ______
2. ______
3. ______
4. ______

Total ______