1) Please calculate the output voltages (Vo) of the circuits shown below.
   a) [6%] Assume the OP-amp is ideal

   ![Circuit Diagram A](image)

   b) [8%] Assume the OP-amp is ideal but with the input offset voltage Vos=15mV

   ![Circuit Diagram B](image)

   c) [8%] Assume the OP-amp is ideal but with the finite open-loop gain G=1000

   ![Circuit Diagram C](image)

2) For the circuit shown below, please calculate
   a) [6%] vo/vi,
   b) [6%] the input resistance Rin, and
   c) [6%] the output resistance Rout

   ![Circuit Diagram D](image)

3) [8%] Consider the transfer characteristic for the circuit below, wherein the OP-amp and
diodes are ideal. Please draw its transfer curve with input voltage $V_i$ from -10V to +10V. On the curve, indicate the slopes and the coordinates (-10V, Vo), (+10V, Vo), and the (Vi, Vo) where the slopes change.

4) The MOSFETs in the two-output current mirror of the figure show below have equal $V_t = 2V$, equal $\mu_nCox = 20\mu A/V^2$, equal $V_a = \infty$, and equal channel length $L = 3\mu m$. Transistor M1 and M2 have the channel widths $W = 12\mu m$ and $W = 18\mu m$, respectively. Neglecting the effects of the output resistance $R_o$,
   a) [5%] please find $V_o$
   b) [4%] please find the channel width of M3 so that $I_3 = 75\mu A$

The current equations in nMOSFET are in the following:
$I_D (triode) = \mu_nCox \frac{W}{L} \left[ \left( V_{GS} - V_t \right) V_{DS} - 0.5 V_{DS}^2 \right]$
$I_D (saturation) = 0.5 \mu_nCox \frac{W}{L} \left( V_{GS} - V_t \right) V_{DS}^{1.5} \left[ \frac{1}{1 + \left( V_{DS}/V_a \right)} \right]$

5) Consider the current mirror circuit of the figure (a) below with $V_{SS} = -5V$ and $I_{ref} = 10\mu A$. Let M1 and M2 be identical, with $V_t = 1V$, $\mu_nCox = 20\mu A/V^2$, $L = 10\mu m$, $W = 40\mu m$, and $V_a = 20V$.
   a) [3%] Find the output resistance
   b) [3%] Find $V_{GS}$ of M1 and M2
   c) [3%] Find the lowest output voltage
For the cascode mirror of figure (b) above, assuming all devices to be identical,

d) [3%] Find the output resistance
e) [3%] Find V_{GS} of M1 and M2
f) [3%] Find the lowest output voltage

6) In the circuit shown below, the MOSFET has V_t = 2V and \( \mu_n \text{Cox} = 50 \mu A/V^2 \), please find
a) [5%] the gain (\( V_o/V_i \))
b) [5%] the input resistance \( R_{in} \)
c) [5%] the output resistance \( R_{out} \)

7) For a CMOS logic circuit which logic function is \( Y \),
a) [5%] Please draw the schematic for \( Y = (A + B) \cdot (C + D + E) \)
b) [5%] Please draw the schematic for \( Y = (A \cdot B) + (C \cdot D \cdot E) \)