Problem 1:
Design a circuit that, when $V_{IN} = \sin(2\pi t)$, produces an output $V_{OUT}$ shown below.

![Graph showing the output voltage](image)

Problem 2:
Suppose $V_a$ and $V_b$ are both positive voltages. What is the output $V_{OUT}$ for the circuit below?

![Circuit diagram](image)

Problem 3:
Suppose $V_a$ and $V_b$ are both positive voltages. Design a circuit for which $V_{OUT} = V_a \cdot V_b$. 

![Circuit diagram](image)
Problem 4:

Let $W/L \mu_n C_{OX} = 1 \, \text{mA}/V^2$, $V_{TH(n)} = 1 \, \text{V}$, $\lambda = 0.1 \, \text{V}^{-1}$.

Find the Thevenin equivalent with respect to $a$ and $b$ in terms of $\Delta V_{GS}$, using the small-signal model.

Problem 5:

Design a circuit which, IN THEORY, produces $V_{OUT} = e^{V_{IN}}$.

Problem 6:

What are some things that would make your design from Problem 5 infeasible?

Problem 7:

Find $V_{DS}$ for the NMOS transistor.

Problem 8:

What would make the Problem 7 circuit a better constant current source than our usual one?
Problem 9:

Let
\( V_1 = V_2 = 10 \text{ V}, \)
\( C_1 = C_2 = 145 \text{ pF}, \)
\( R_{\text{coil}} = 20 \text{ k}\Omega, \)
\( R_1 = R_2 = 10 \text{ k}\Omega. \)
Coil holds the switch in place as long as it voltage exceeds 5 V.

Suppose I hold the switch down long enough to fully charge \( C_2 \) and then flip the switch up (and let go) instantaneously at \( t = 0 \).

Sketch \( V_{\text{out}}(t) \), or state which time intervals \( V_{\text{out}}(t) = 1 \text{ V} \) and when \( V_{\text{out}}(t) = -1 \text{ V} \).

Problem 10:

For the circuit, graph, and tree shown above:

a) Determine the fundamental cut set for each tree branch.

b) Consider the two supernodes that each fundamental cut set creates. Write a KCL equation for each fundamental cut set.

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