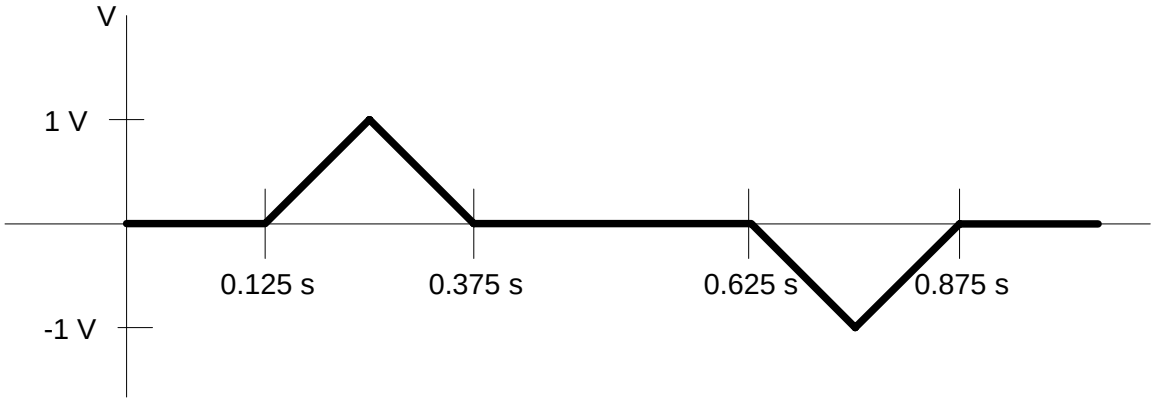
EE 40

Final Exam Review Problems Set 1

Challenging! Medium to Hard Difficulty

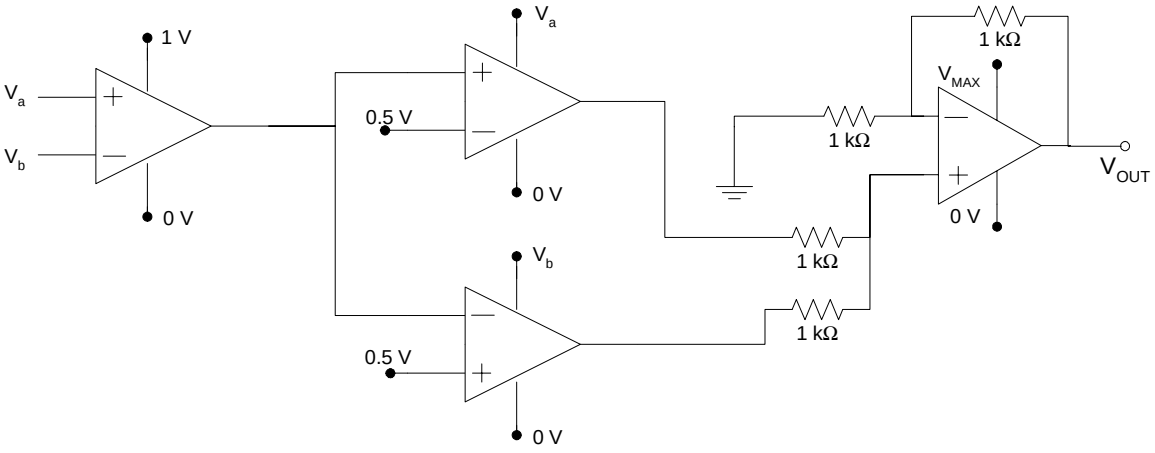
Problem 1:

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



Problem 2:

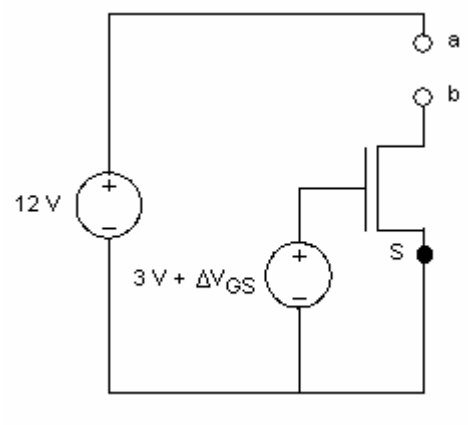
Suppose V_a and V_b are both positive voltages. What is the output V_{OUT} for the circuit below?



Problem 3:

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

Problem 4:



Let $W/L\mu_N C_{OX}$ = 1 mA/V^2, $V_{TH(N)}$ = 1 V, λ = 0.1 V^{-1}.

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

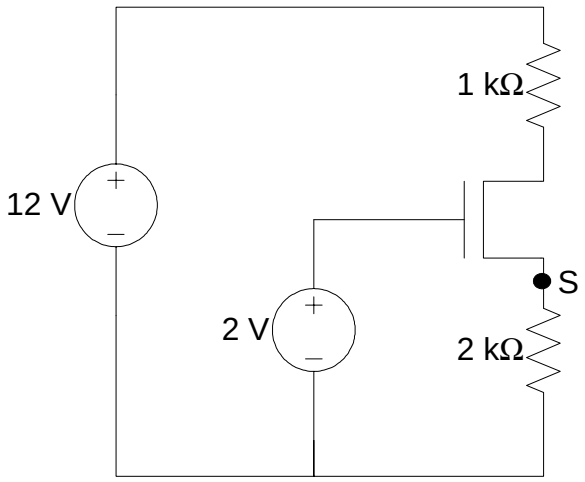
Problem 5:

Design a circuit which, IN THEORY, produces $V_{OUT} = e^{V_{IN}}$. The design only needs to work "on paper".

Problem 6:

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

Problem 7:



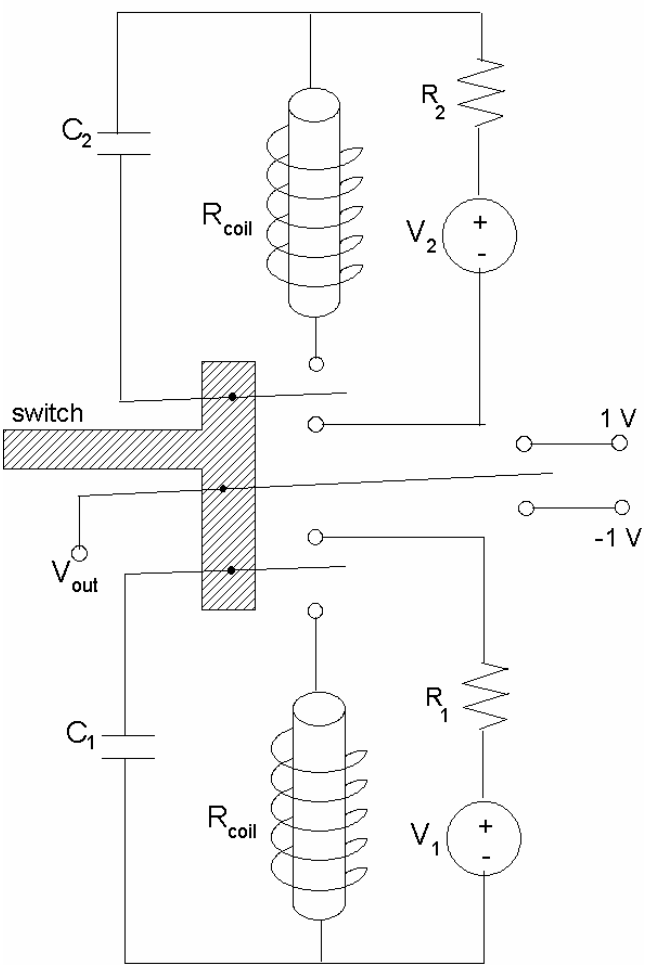
$W/L\mu_N C_{OX}$ = 200 μA/V^2, $V_{TH(N)}$ = 1 V, λ = 0 V^{-1}.

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:

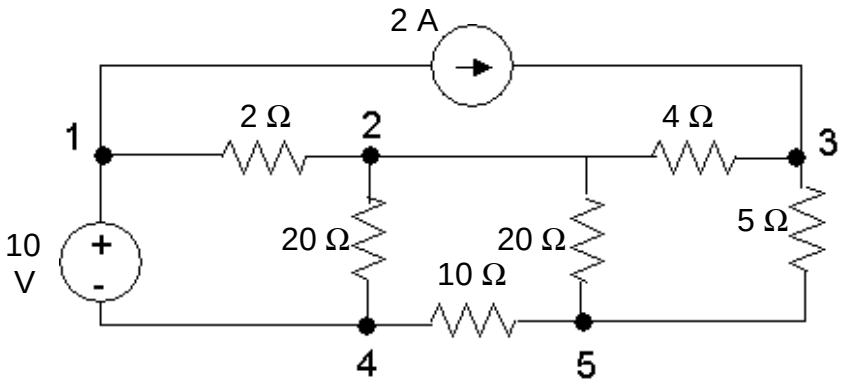


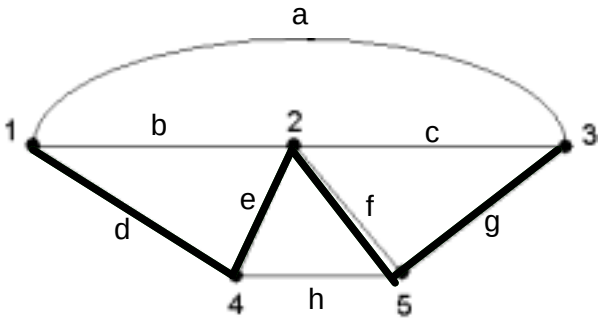
Let
$V_1 = V_2 = 10$ V,
$C_1 = C_2 = 145$ pF,
$R_{coil} = 20$ kΩ,
$R_1 = R_2 = 10$ kΩ.
Coil holds the switch in place as long as it voltage exceeds 5 V.

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