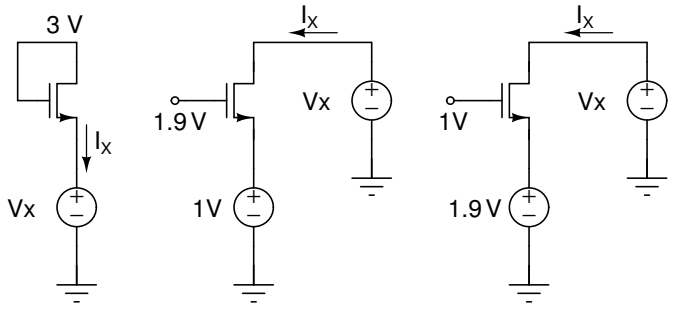
EC201-ANALOG CIRCUITS : PROBLEM SET 2

shanthi@ee.iitm.ac.in

Problem 1

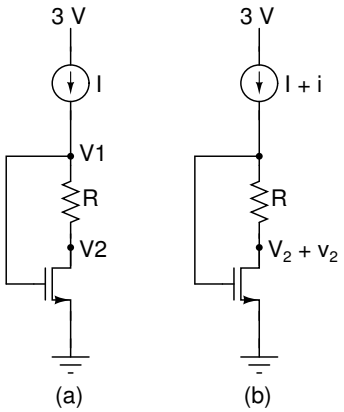


k = 100 μA/V^2, (W/L) = 10, V_T = 0.7 V, λ = 0

Figure 1: Circuit for Problem 1

For each of the circuits shown above, plot I_x as V_x varies from 0-3 V.

Problem 2



k = 100 μA/V^2, (W/L) = 10, V_T = 0.7 V, λ = 0

Figure 2: Circuit for Problem 2

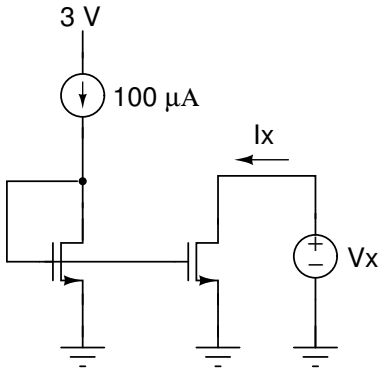
For the circuit (a) shown above, determine the minimum value of I required to make the MOSFET operate at the edge of the active region. In the circuit (b) shown above, determine the incremental voltage v_2 in terms of the incremental current i, assuming the device is in saturation. How will you choose R to make v_2 independent of i ?

Problem 3

For the circuit shown above, sketch I_x as V_x varies in the range 1-3 V.

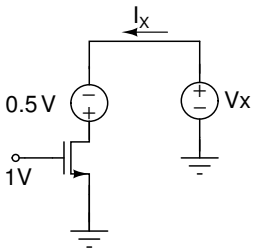
Problem 4

For the circuit shown above, sketch I_x as V_x varies in the range -0.5-3 V.



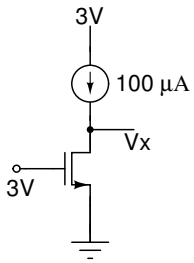
k = 100 μA/V^2, (W/L) = 10, V_T = 0.7 V

Figure 3: Circuit for Problem 3



k = 100 μA/V^2, (W/L) = 10, V_T = 0.7 V, λ = 0

Figure 4: Circuit for Problem 4



k = 100 μA/V^2, (W/L) = 10, V_T = 0.7 V, λ = 0

Figure 5: Circuit for Problem 5

Problem 5

For the circuit shown above, determine the region of operation of the transistor. Find Vx.

Problem 6

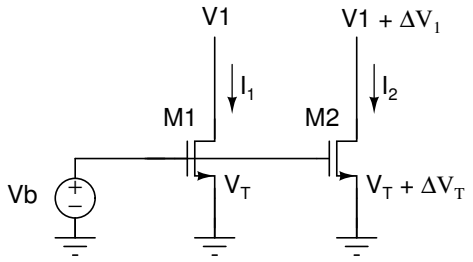


Figure 6: Circuit for Problem 6

In the circuit shown above, it is known that both M1 & M2 operate in saturation. Further, $\mu_n C_{ox}$ and W/L for both transistors is the same. The threshold voltage of M2 is *slightly* larger than that of M1, by an amount ΔV_T. Determine I_2. Assume $\Delta V_1 \ll V_1$.

Problem 7

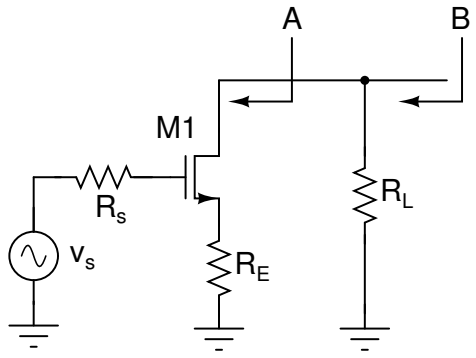


Figure 7: Circuit for Problem 7

The small signal equivalent circuit of an amplifier is shown above. M1 is assumed to be in saturation, with transconductance g_m. Determine the Norton equivalent looking in at A, as well as the Thevenin equivalent looking in at B. What happens to these equivalents when $g_m \to \infty$?

Problem 8

Determine the quiescent operating point and small signal gain of the amplifier shown. What is the maximum permissible amplitude of the sinewave input so that clipping of the output is avoided ?

Problem 9

The input to the amplifier shown above is a sinusoid of amplitude A. Determine R1, R2, A, Vdd and Vss in the circuit to achieve the following.

- There must be no quiescent current flowing through the load and source.
- The incremental gain must be -4.
- The output sinewave must begin to just begin to clip at both extremes.

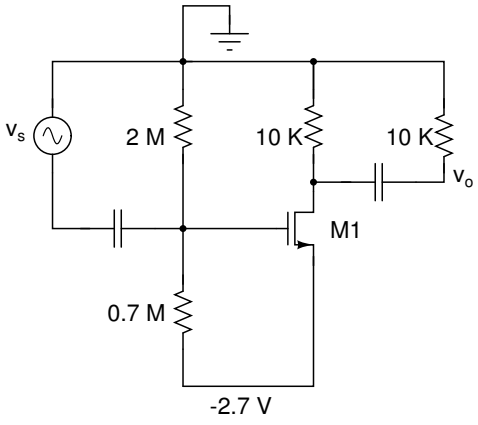


Figure 8: Circuit for Problem 8

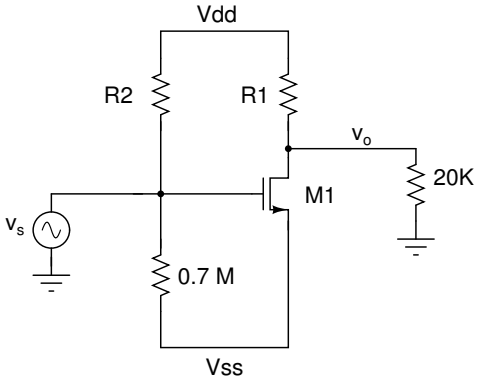


Figure 9: Circuit for Problem 9