MASSACHVSETTS INSTITVTE OF TECHNOLOGY
Department of Electrical Engineering and Computer Science

6.002 – Electronic Circuits
Fall 2001

Problem Set 7

Issued: October 18, 2001 Due: October 26, 2001

Readings:

- Agarwal & Lang Chapter 11 for Thursday, October 18.
- Agarwal & Lang Chapter 13 for Tuesday, October 23.
- Agarwal & Lang Sections 14.1 and 14.3 for Thursday, October 25.

Problems:

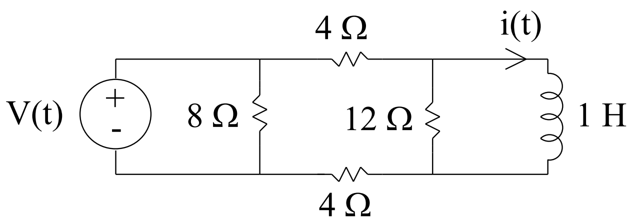
1. The network shown below has zero initial state. That is, the inductor current $i(t)$ is zero at $t = 0^-$. At $t = 0$, the voltage source delivers an impulse of area 100.

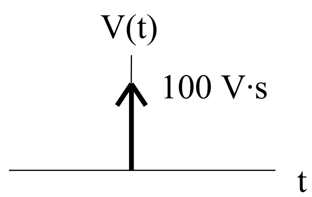
   (a) Derive the differential equation relating i(t) and V(t).

   (b) Find the inductor current i(t) at $t = 0+$.

   (c) Find the inductor current i(t) at $t = 1000$ through physical, rather than mathematical, reasoning.

   (d) Write an explicit equation for $i(t)$.

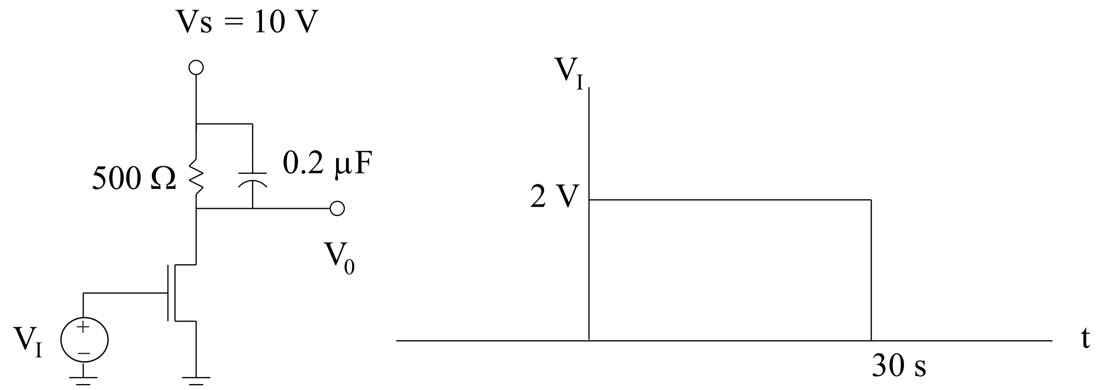




2. Do Problem 19, p. 693 A&L.

3. In the circuit given below, the threshold voltage $V_T = 0V$ and the value $K = 2 \times 10^{-3} A/V^2$. The input V_I is depicted beside the circuit.

   (a) Does the MOSFET operate in the saturated regime? Over what time intervals?
   (b) Write an explicit expression for the output voltage for $t \leq 30\mu s$.
   (c) Write a differential equation that governs the value of output at time $t \geq 30\mu s$.
   (d) Write an explicit expression for the output voltage for $t \geq 30\mu s$.



4. For the circuit below, $v_s(t) = 2 + 0.01u(t)$. The threshold voltage of the MOSFET is $1V$, and $K = 2mA/V^2$. The voltage $v_c(t)$ across the capacitor is measured from drain to gate.

   (a) Compute the bias value of v_c for $t < 0$. You may assume that the capacitor has the voltage that would appear between the drain and the gate if the capacitor were not present.
   (b) Make an incremental model of the circuit for the bias conditions you found in part (a).
   (c) Determine the differential equation for the incremental output voltage in terms of the incremental input voltage.
   (d) Give an algebraic expression for the incremental output voltage as a function of time for $t \geq 0$.
   (e) Sketch the incremental output voltage as a function of time for $0 \leq t < 100\mu s$.