Homework 4 (Lecture 8-10)
Total points: 105

Please write down clearly the calculation/thinking process of each question. Unit is needed when applicable.

Due: December 26th, 10:10am.
Total: 110 points

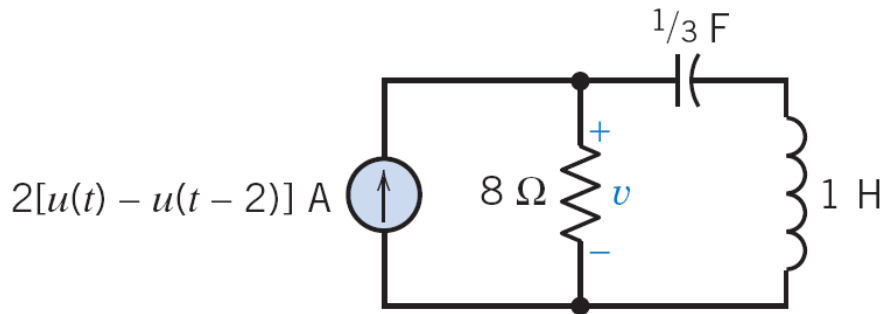1. Find v(t) for t ≥ 0 for the circuit in Figure 1. (20%)

Figure 1

2. Consider the circuit in Figure 2. The elements have the values: R = 200 Ω, C = 200 nF, and L = 50 mH. The initial inductor current $i_L(0)$ is -45 mA, and the initial capacitor voltage v(0) is 15 V.

    a) Calculate the initial current in each branch of the circuit. (10%)

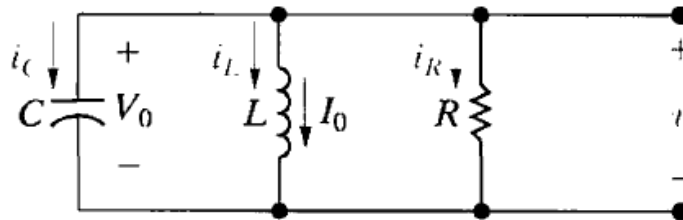   b) Derive v(t) for t ≥ 0. (10%)

    c) Derive $i_L(t)$ for t ≥ 0. (10%)

Figure 2.

3. The 0.1 µF capacitor in Figure 3 is charged to 100 V before t = 0. At t = 0, the capacitor is discharged through a series combination of a 100 mH inductor and a 560 Ω resistor.

    a) Derive i(t) for t ≥ 0. (10%)

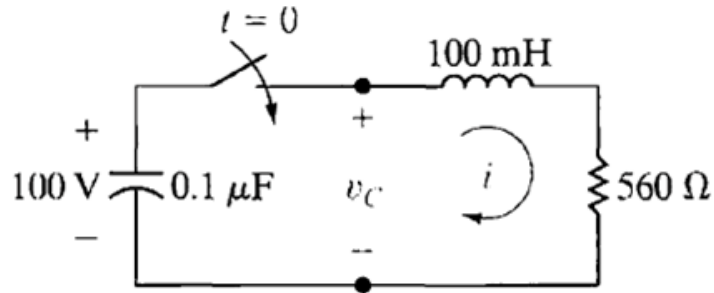   b) Derive and plot $v_C(t)$ for t ≥ 0. (15%)

Figure 3.

4. Consider the CMOS inverter in Figure 4. Find the static power and dynamic power of this circuit. The input voltage v_{in} is a 10-MHz square wave. The on resistor of the MOS is R_{on} for both PMOS and NMOS. R_{on} = 10 Ohms. The inverter state is fully settled in each half cycle (during charging and discharging the capacitor). (25%)
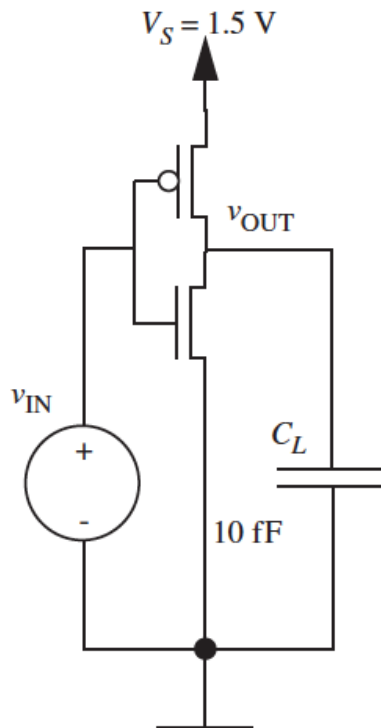

$V_S = 1.5$ V

v_{OUT}

v_{IN}

C_L

10 fF

Figure 4.

5. Assume a circuit has m NMOS inverters connected in series with $m \gg 1$. Each inverter is built with an NMOS and a resistor R_L. The power supply is V_S and the on resistor of each NMOS is R_{on}. Find the static power of the inverter chain. (10%)