## EE 40

## Homework \#2

Due Tuesday, February 11
(in class, in the drop box by start of class, or in 477 Cory by 7 PM)
30 Total Points Possible

## Problem 1: 8 Points Possible

Consider the following RC circuit, which models a logic gate. The voltage source Vin can be instantaneously switched to 0 V or to 5 V to resemble logic 0 or logic 1, respectively. Use $R=2 k \Omega$ and $C=5 \mathrm{pF}$.


Let's say that we allow at least $5 \tau$ between input voltage transitions, to allow the output to reach over $99 \%$ of its desired level.
a) Compute the energy absorbed by the resistor over a period of $5 \tau$, when Vin transitions from 0 V to 5 V and the capacitor is initially discharged.
b) Do the same for Vin transitioning from 5 V to 0 V with Vout initially at 5 V .
c) Determine the maximum number of computations (transitions) that can be performed in one second, with the transitions occurring as often as once every $5 \tau$.
d) Determine the maximum amount of energy absorbed by the resistor in one second, with the input transitions occurring as often as once every $5 \tau$.

## Problem 2: 8 Points Possible

The boss wants to improve the performance of the logic gate in Problem 1. He asks his employees to reduce the time constant somehow.


Ted finds materials with less resistance, so $R=400 \Omega$ (capacitance stays the same).
Dilbert finds new devices with less capacitance, so C $=2 \mathrm{pF}$ (resistance stays the same).
Who has the better solution? Compare the solutions in terms of increase in computation speed (time constant reduction) and in terms of power dissipated by the resistor.

## Problem 3: 8 Points Possible

Consider the circuit at right, with unknown resistor values $R_{1}$ and $R_{2}$.
I measure the voltage $\mathrm{V}_{1}$ using a voltmeter with internal resistance $2 \mathrm{M} \Omega$, and the reading is 5.00 V .

I measure the current I using an ammeter with internal resistance
 $1 \Omega$, and the reading is $12.5 \mu \mathrm{~A}$.
a) What are the values of $R_{1}$ and $R_{2}$ ?
b) I measure the voltage $\mathrm{V}_{2}$ using the same voltmeter, and the reading is 3.33 V . Has KVL been violated? Is there something wrong with the meter? Identify and explain the discrepancy.

Problem 4: 6 Points Possible
Find currents $\mathrm{I}_{1}, \mathrm{I}_{2}$ and $\mathrm{I}_{3}$ in this circuit.


