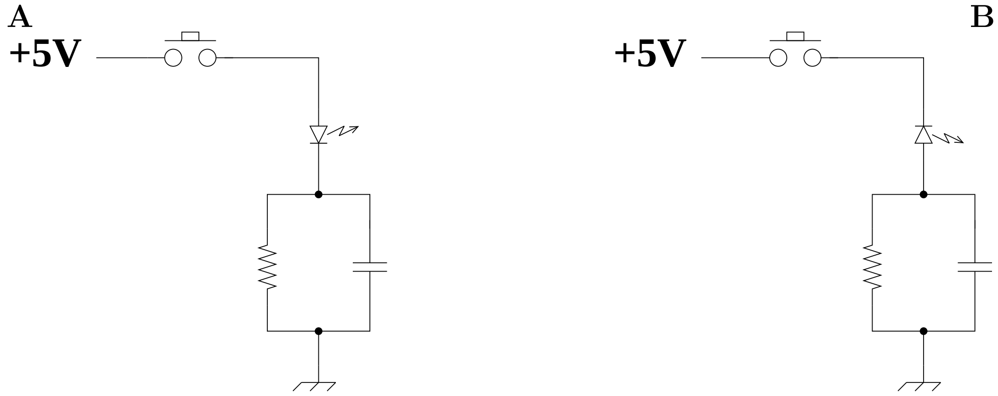
Embedded Systems (CS 503/591C)
Homework 2 Solutions

November 20, 2003

This homework assignment is due Thursday, November 13. Feel free to discuss this assignment with the TAs, the instructor, or your fellow students. But - the work that you hand in must be your own.

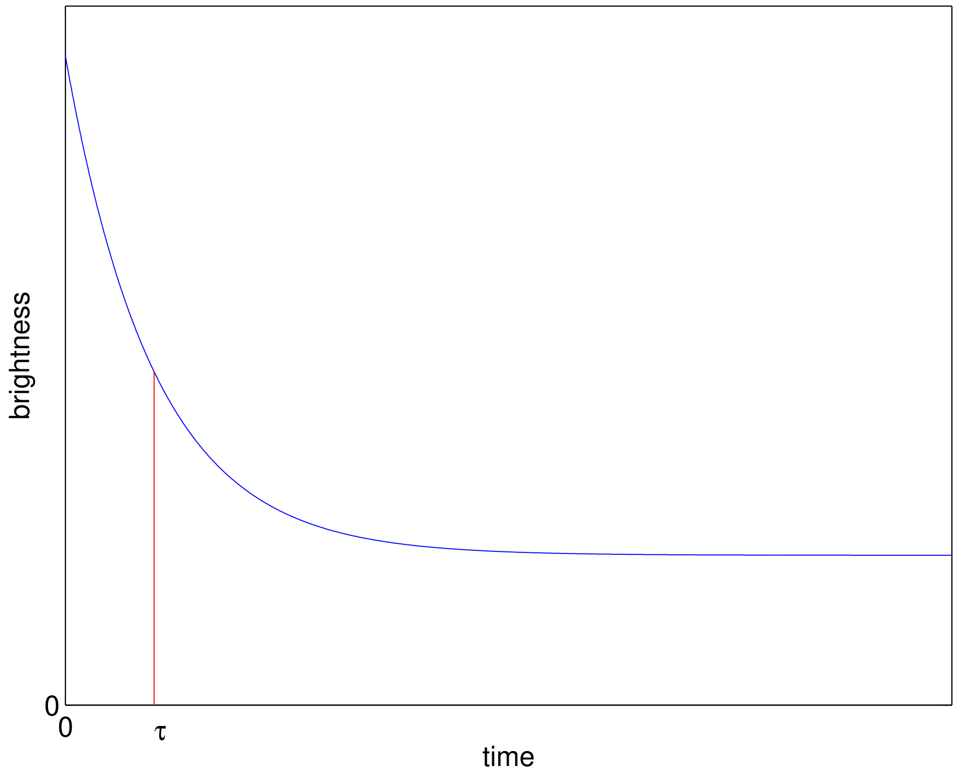
Question 1

Consider the following circuits:



Please give answers to the following questions (with explanations):

1. Figure A: assume that at time $t = 0$ the switch transitions from an opened state to a closed state. Sketch the brightness of the LED as a function of time. Make sure to indicate the location of zero brightness and of 1 time constant.



As soon as the switch closes, we will see a very high brightness (due to the nearly uninhibited current flow to the capacitor). However, in the limit, the current flow through the LED is dominated by the resistance. Note that brightness is not zero in the limit.

2. Figure A: assume that at time $t = 0$ the switch transitions from a closed state to an opened one. Sketch the brightness of the LED as a function of time.

   Once the switch is opened, the LED is no longer within a completed circuit. Therefore there is no current flow and no photons are emitted.

3. Figure B: assume that at time $t = 0$ the switch transitions from an opened state to a closed state. Sketch the brightness of the LED as a function of time.

   There is no current flow through the LED due to its polarity; there will be no photon emission.

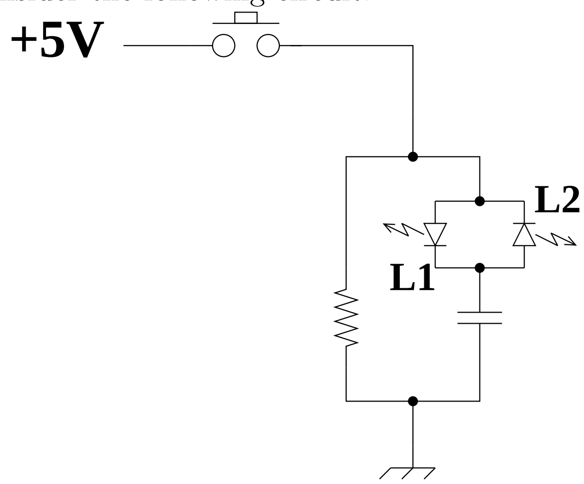
4. Figure B: assume that at time $t = 0$ the switch transitions from a closed

state to an opened one. Sketch the brightness of the LED as a function of time.

There is no current flow through the LED due to the fact that it is not within a complete circuit.

Question 2

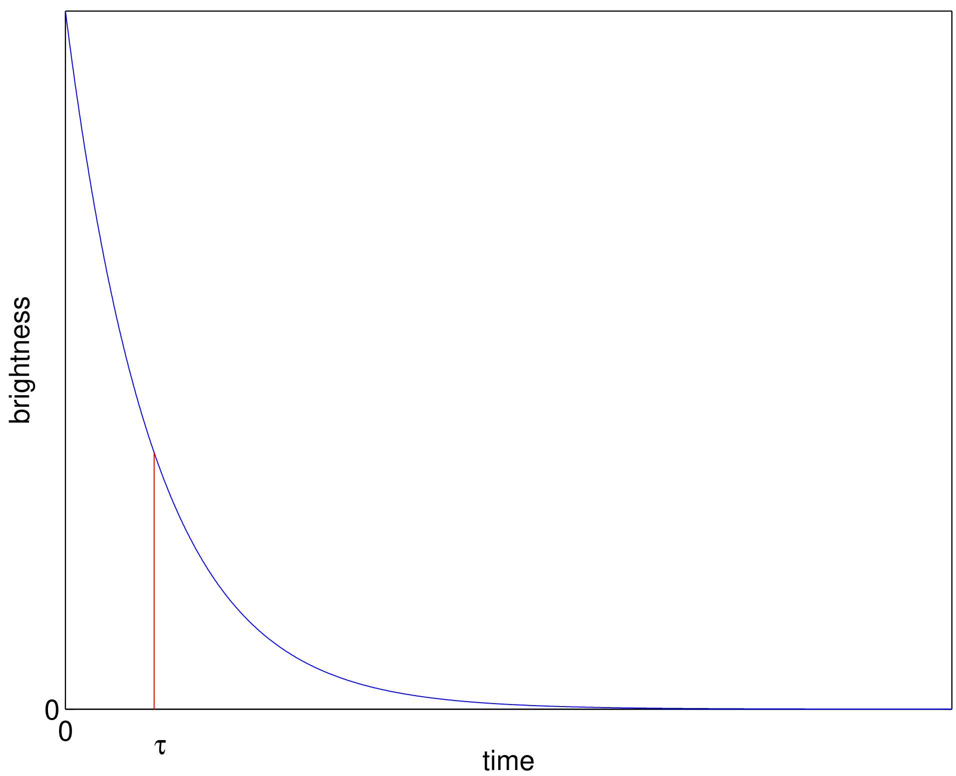
Consider the following circuit:



Please give answers to the following questions (with explanations):

1. Assume that at time $t = 0$ the switch transitions from an opened state to a closed state. Sketch the brightness of LED 1 and LED 2 as a function of time. Make sure to indicate the location of zero brightness and of 1 time constant.

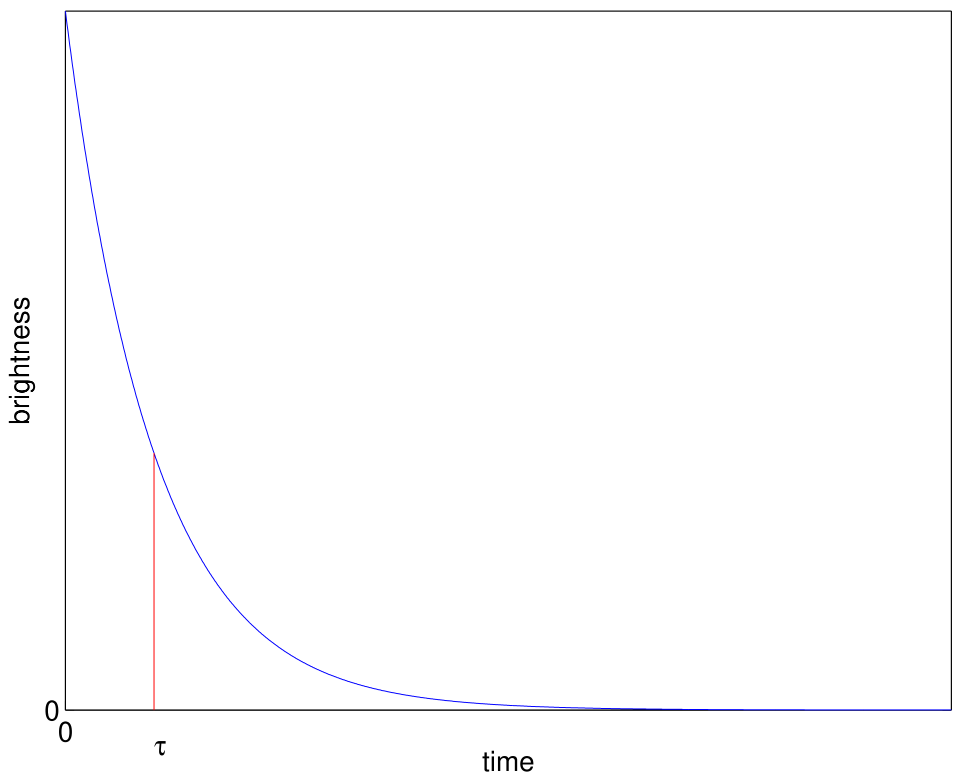
   The brightness of LED 1 will be as follows due to the current flow INTO the capacitor. In the steady state, there is no current flow into the capacitor. Therefore the brightness of the LED becomes zero.



There is no current flow through LED 2 because of its polarity (so no photon emission).

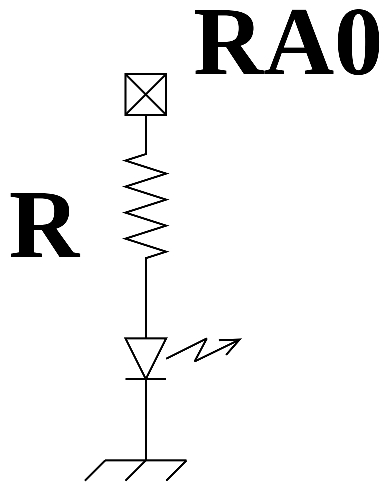
2. Assume that at time $t = 0$ the switch transitions from a closed state to an opened state. Sketch the brightness of LED 1 and LED 2 as a function of time.

   In this case, the current flow will be away from the capacitor. So: LED 1 will not emit any photons and the brightness of LED 2 will be as follows:


brightness
0
0
τ
time

Question 3

Suppose we have a green "Super Bright" LED (specifically, RL5-G5030) connected to our PIC in the following way:



When the LED turns on, we would like it to be as bright as possible (within the specifications of our hardware).

1. What is the max current that our PIC can source?

   25 mA

2. What is the max sustained current that the LED can handle?

   20 mA

3. What is the max current we should use in this circuit?

   20mA

4. What is the voltage drop across the LED at this current level (approximately)?

   about 3.6 V

5. What is the appropriate resistance that we should use in the circuit in order to obtain maximum (safe) brightness?

   $(5V - 3.6V)/.02A = 70\Omega$

Question 4

Suppose we want to modulate our piezoelectric speaker at $610.35Hz$.

1. What timer should we use?

   Timer 0 will work

2. How should we configure the timer?

   Use a prescaler of 16 so that we interrupt at $1220.7Hz$ *so that we can toggle the speaker at the appropriate frequency.*

Question 5

Suppose we want to flash an LED at $4.77Hz$.

1. What timer should we use?

   Timer 1 is necessary

2. How should we configure the timer?

   Use a prescaler of 8 so that we interrupt at $9.53Hz$ *so that we can toggle the LED at the the appropriate frequency.*

Question 6

Suppose we want to sample a digital input line at precisely $2.155KHz$.

1. What timer should we use?

   Timer 2 is necessary

2. How should we configure the timer?

   Use a prescaler of 16, a postscaler of 5, and a timeout of 29.

Question 7

How much time did you spend on this assignment?