# Midterm Examination for ME 218a

Due by 5:00pm on October 29, 1993

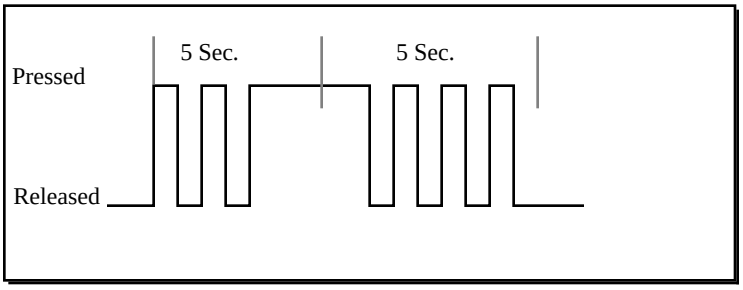
## Problem #1 5 Points

Given 3 LEDs, each w/ $V_f$=1.8V@20MA, all to be powered by a 6V supply. Design a circuit that will deliver 20mA to each LED while minimizing the wasted power. You don't need to turn them on & off, just power them.

## Problem #2 30 Points

Design a security system, using logic gates, to unlock a gate when the right 'code' is entered on a single push-button switch. The system must have an arming switch that disables the lock in one position and enables it in another. A push-button will trigger the system when the following sequence of button presses is performed:

3 presses, hold after the third press until 5 seconds from the initial press, then 3 more presses and release before 10 seconds from the initial press.




To help the user and confuse the unwary, the system will toggle the state of a status LED at the 5 seconds after initial trigger point. When successfully triggered, the system will engage a 12V solenoid with a coil resistance of 48Ω for 10 seconds after successful completion. After the 10 second engagement, the system will re-arm. **Don't panic**. we have gone over the necessary analysis. Go methodically through what is happening and you will be fine. Be SURE to thouroughly document HOW your design works.

## Problem #3 10 Points

a) Given a 12V supply with an output impedance of 40Ω, design a circuit to provide a constant 3.6V at 0-25mA. List key parameters, be specific and use numbers, of the devices in your design. You don't need to pick real devices, just list the important specs that you would use in evaluating real devices.

b) If the 12V supply had an output impedance of 0.1Ω, suggest another approach to reducing the 12V to a regulated 3.6V. This should be a completely different approach, not just new values in your original design.

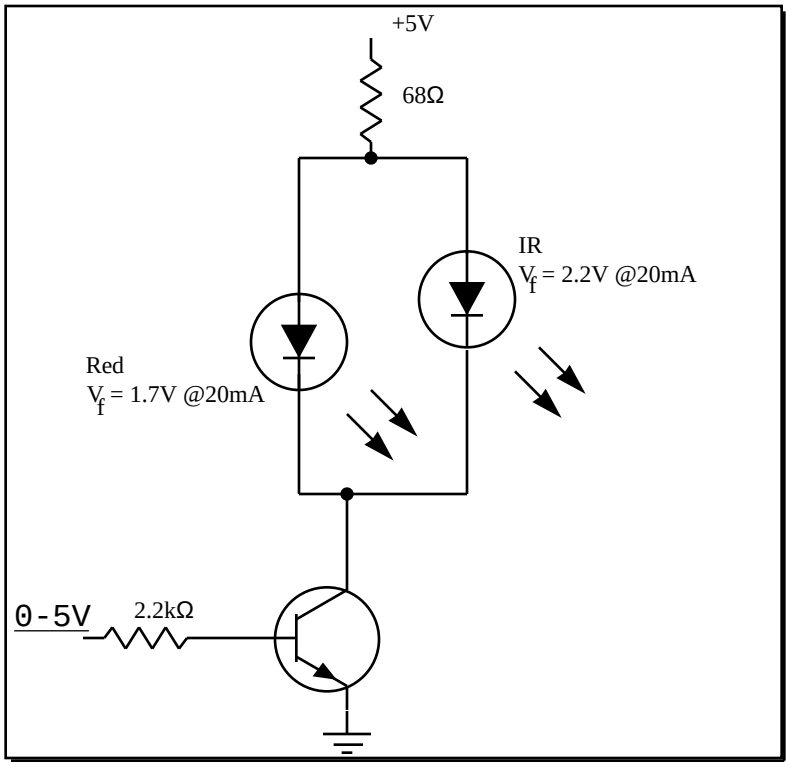
## Problem #4 15 Points

Given a Photo-resistor with R=20K in the dark and R=1K in 5mW/cm$^2$ (Linear response between). Design the electronics for a control system that will turn on a 5Ω room lamp (conveniently powered by 12V DC) if the light level falls below 2.75mw/cm$^2$ and turns the lamp off if the light level rises above 4.94 mW/cm$^2$ .

## Problem #5 5 Points

Given a 74LS05 driving 3 LSTTL inputs, design a pull-up resistor that will result in minimum power dissipation in the output stage of the 'LS05.

## Problem #6 20 Points



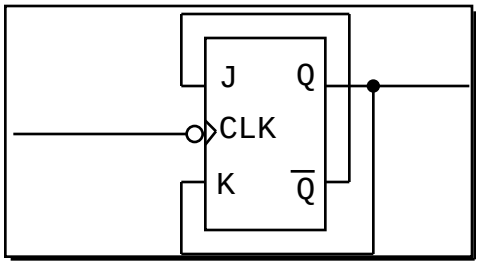

Your friend at the next lab bench has designed the circuit above to light two LEDs. The goal is to use an Infra-Red (IR) LED as part of a communications link, driven by an LSTTL device. Realizing that IR is difficult to see, your lab-mate has added a visible LED in parallel with the IR LED, so that they might tell if their drive circuitry was working. They've come to you for help since it doesn't seem to be working properly. The LEDs seem to be working (at least the visible one is) but they don't seem to be getting anything on their receiver. Someone else has already checked out the receiver, and it is working OK. Can you help them figure out what's wrong and then help them fix it? Please explain to them what was wrong and how you fixed it.

## Problem #7 5 Points

Given an inputs signal that is a variable duty cycle square wave between 0 and 5V at 20Hz. Design a circuit to produce an output voltage proportional to the duty cycle of the input signal with no more than 10mV ripple @ 50% duty cycle..

## Problem #8 10 Points

The following questions refer to the drawing below.




a) If the input is a 1Mhz square wave, make a drawing to describe the output waveform, be sure to label **everything**.

b) If the device in the drawing above is a 74HC73, operating at 4.5V Supply. What is the maximum frequency of a square wave that could be applied to the input and still maintain the function observed in part A over the full temperature range? Do you need to make any assumptions ? if so what are they ?

You should assume that the clear input of the 74HC73 is held in the inactive state. That is, the device is not held in the clear state, but operates normally. Hint: the HC devices are High Speed CMOS, find a data book!