ME218a Midterm Exam

Due by 4pm on 10/24/97

Name:_____

I Certify that I have taken this examination in compliance with the Stanford University Honor Code.

_____

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Include this as the cover sheet for you solutions

The Midterm Web Forum is at:

`http://36.37.0.17/HyperNews/get/Midterm97.html`

Midterm Examination for ME 218a

Due by 4:00pm on October 24, 1997

#1_____

#2_____

#3_____

#4_____

#5_____

Total_____

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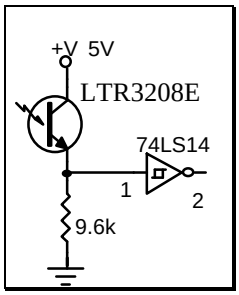
Problem #1 15 Points



The Designer of this circuit believes that the photo-transistor should be saturated at E = 0.5mW/cm^2

a) What is the logic level at the output of the 74LS14 if the light falling on the photo-transistor is 1mW/cm^2 ?

b) What is the voltage at pin 1 of the 74LS14 under the same conditions as part a ?

c) What is the voltage at pin 1 of the 74LS14 if the light level is reduced to 0mW/cm^2 ?

d) What is the logic level at the output of the 74LS14 under the same conditions as part c ?

e) What modifications, if any, would you make to this design to properly indicate a logical low in the presence of >0.5 mW/cm^2 light level and a logical high for no light ?

Problem #2 30 Points

You are to design a digital combination lock that will accept the combination 1-1-4-5. The number is to be entered, in binary, on a set of four toggle switches. A push-button (***Enter***) will be closed for at least 500mS after each digit is entered. After the fourth digit has been entered, a second push-button (***Open***) may be pressed (closed) to generate a logical high signal to open the lock. This signal should remain active for as long as the (***Open***) push-button is pressed. When the open push-button is released, the lock should reset to the state before any valid numbers were pressed. If an improper digit is present on the binary switches when the enter button is pressed, the lock should also reset. Choose components available in the 74HC family for your design.

Problem #3 15 Points

To open the door lock from problem #2 requires activating a solenoid that needs 1A to actuate. The coil resistance of the solenoid is 4.9Ω. The only power available is a 5V supply. Design a circuit to actuate this solenoid using the output signal from problem #2 as the control. Limit your design to components that have been introduced in either lecture or lab.

Problem #4 15 Points

Another designer proposes to use a different solenoid. It still requires 1A to actuate, but it has a coil resistance of 4.8Ω and has one of the coil leads tied to the case (which must be held at ground potential). Design your circuit using parts available from your lab kit and operating at typical specifications. As in problem #3, the only supply available is 5V and the control signal will come from the circuit of problem #2.

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Problem #5 25 Points

You have been asked to design a wheel slip indicator for an automotive application. As inputs, you have been provided with two encoder signals that produce an HCMOS pulse train related to wheel speed. At a constant speed, the pulse train has equal high and low times. The maximum frequency of the encoder signal is 50kHz. You are to design a circuit that will indicate (low) if the two wheel speeds are within approximately +-10% of one another. Evaluation of the relative speeds must occur at a rate no less than once for every ten pulses from the encoder signal chosen as the reference (either will work). If the 10 cycle average of the second encoder signal is 15% or more faster or slower than the reference signal, the output of the slip indicator should be a continuous high. The output should return to continuous low no more than 10 pulses of the reference signal after the 10 cycle average speed difference falls below 10% .