ME218a Final Exam

Due by 5pm on 12/15/94

Name:_____

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

_____

This is the cover sheet for what you turn in !

#1_____

#2_____

#3_____

#4_____

#5_____

Total_____

Problem #1 5 Pts

Your lab-bench mate has asked you to help them debug their op-amp circuit. It is supposed to have a gain of 10, but they report that the output seems stuck at 0. The schematic of what they have built is shown below. Can you explain to them what they've done wrong and offer suggestions as to how to get the circuit to work ?

Problem #2 5 Pts.

You did such a great job on that last problem that you've developed a reputation as an op-amp Guru. Someone else has now asked you to help them with another op-amp circuit.

Their problem is different though. They get something out, it's just not what they expect. They put in a signal that looks like:

And get something out they say looks like a square wave with rounded corners. After confirming that their 'scope probe is properly calibrated (it is) you ask if there is anything else they can tell you about the circuit. They reply that they have tried measuring node voltages, but can't make sense of what they found. The results seem to violate the golden rules that Ed drilled into them. Here's what they got:

Can you explain to them what is happening in the circuit and suggest ways to modify it to make it work?

Problem #3 20 Pts.

Using the photo-transistor and other ICs supplied in your kit, design a circuit to light one of three LEDs based on light level. When the light level is generally rising:

If the light is less that 0.1mW/cm^2 then light a red LED with V_f = 1.7V @ 20mA
if the light is between 0.1 and 0.25 mW/cm^2 then light a green LED with V_f = 2.2V @20mA
If the light is over 2.5mW/cm^2 then light an orange LED with V_f = 1.8V@ 20mA.

You have only a 5 volt supply available to power this circuit.

The LEDs should not flicker (on-off-on or off-on-off) if there is a sudden rise then fall or fall then rise of 10% of the light level.

Note: Yes, there is a time when no LEDs will be on.

Problem #4 30 Pts.

You have been asked to design the drive circuitry for a small but powerful 12V DC motor. The motor will be controlled by two bits from a 68HC11. One bit will control the direction of the motor and the second bit will enable or disable the motor. The specs that you have been provided are:

+12 and +5V are available for this design

The coil resistance of the motor is 4Ω.

Because of purchasing constraints, you may only use standard 74LSxxx series logic, TIP series transistors, 1N4xxx series diodes, standard 5% resistors in 1/3, 1/2 or 1W power ratings and ULN2003s.

In addition to designing the circuit, the project leader has asked you to make recommendations to maximize the reliability of your design when it is turned into a PC board and wired into the product.

Problem #5 50 Pts.

You did such a good job on that motor drive circuit that you've been given more responsibility. You have been asked to design and supervise the implementation of the user input system for another product.

This product will have a limited keyboard, A-Z, 0-9, ENTER and two programmable function keys F1 and F2. The function keys will be used by the main software to implement 'soft keys'. These keys are programmable by the main software so that, depending on the mode of the machine, they will return different values in each of the different modes.

Your purchasing agent misunderstood your specifications and got you a batch of keys with *at least* 10mS of contact bounce. Fortunately you were able to test these switches and have found that they have *no more than* 15mS of contact bounce.

Your purchasing agent scored another coup, finding a tremendous deal on a huge batch of 74C923 keyboard encoder chips, so you've been directed to use them in your design.

You've been told that the keyboard circuitry will interface to a 68HC11 using 8 port lines. However, it's still early in the design process and you are not sure just which 8 port lines you'll get. For this reason the

design of the software and the hardware should be kept as generic as possible, isolating the interactions with the port lines so that they can be easily changed later in the design.

Wait, software you say ? Yes, with your new job comes new responsibilities. You have an apprentice programmer working for you. Their job is to write the keyboard interface module that will be called by the main product software (which someone else is writing). Being a Stanford CS106 graduate, they have a reasonable grasp of C syntax, but really need direction from you. You should provide them with a module design that will describe how to implement the keyboard interface software. Don't go overboard here and do their job for them, just provide a detailed design and 'leave the coding to them'. Your design should account for how the keyboard encoder chips work, how the hardware is configured and provide the following hi-level functions to the rest of the program:

`char KBKeyPressed(void)` returns a 1 if a key is pressed, 0 otherwise

`char KBGetKey(void)` if a key is pressed, returns the ASCII value of the key. If no key is pressed it waits until a key is pressed before returning it's ASCII value.

`void KBProgFKey( WhichKey, Value)` assigns the value that will be returned by a programmable function key. `WhcihKey` determines if F1 or F2 is to be programmed and `Value` determines the ASCII value that will be returned when that key is pressed.

The documentation that you submit should include a schematic, with the keys labeled. An overview description of the software module and how it works and finally the detailed design for the module software.