Introduction To Embedded System Design

Assignment Solutions- Week 5

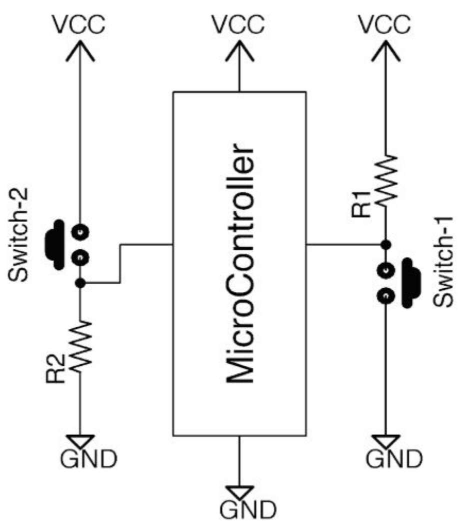
1. Which of the following is not an input device?
    A. DIP switch
    B. Microphone
    C. LCD
    D. Light sensor (LDR)

Explanation: LCD is an output device because it displays the data from the computer to the user whereas rest of the devices are all some form of input device (DIP switch- manual Electrical switch, Microphone-voice input, LDR- light input)

2. Which kind of switch should be preferred when more than two outcomes/states of a switch are needed?
    A. Toggle switch
    B. DIP switch
    C. Push button
    D. Rotary switch

Explanation: Toggle Switches, DIP Switch, Push Button only have two states. As we know, in Rotary switches we have two options either rotate clockwise or anticlockwise. Each direction will behave as an outcome and degree of rotation will behave as the amplitude of outcome. The most common example of usage of Rotary Switch is in Car stereo volume control.

3. In the diagram shown below, assume that the microcontroller is operating at 3.3V, VIH is 1.45V, VIL is 0.65V, I+/I- (leakage current at port pin) is 60nA. What would be the maximum value of resistor R1 And R2 respectively? (Take 0.2V as margin above VIH and below VIL)

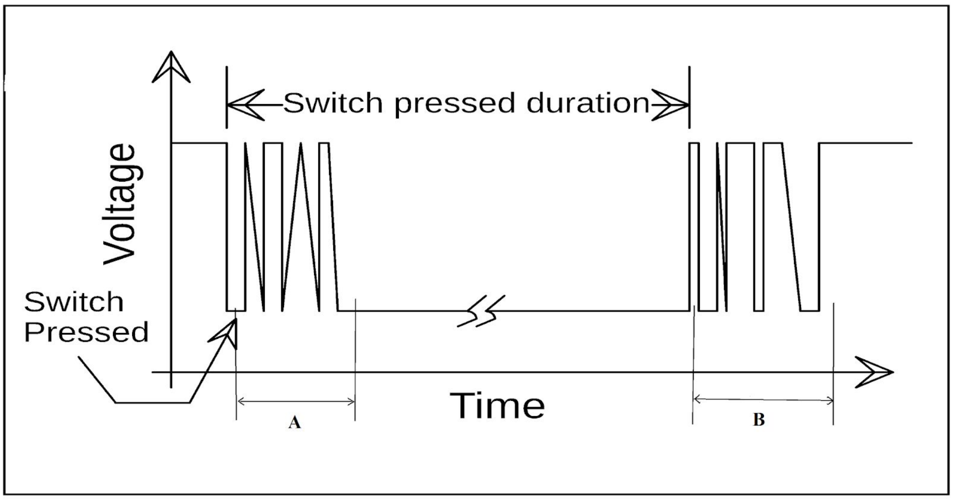


A. 30Mohm, 10Mohm
B. 27.5Mohm, 7.5Mohm
C. 27.5Mohm, 10Mohm
D. 30Mohm, 7.5Mohm

Explanation:
Calculation of R1: When the Switch-1 is pressed, the microcontroller pin at which switch-1 is connected will be at Logic Low. For the pin to be at Logic High when the Switch-1 is not pressed, the Voltage at that pin should be above VIH (+ 0.2V considering the margin). So, when the switch is not pressed, the leakage current will flow from VCC through R1 and into the microcontroller pin.
Therefore, $R1 = (VCC - (VIH + 0.2V))/I$
R1 = (3.3V- (1.45V +0.2V)) / 60nA
R1 = 1.65 V / 60nA
R1 = 27.5 MOhm

Calculation of R2: When the Switch-2 is pressed, the microcontroller pin at which switch-2 is connected will be at Logic High. For the pin to be at Logic Low when the Switch-1 is not pressed, the Voltage at that pin should be below VIL (- 0.2V considering the margin). So, when the switch is not pressed, the leakage current will flow from the microcontroller pin through R2 and into the GND.
Therefore, $R2 = (VIl - 0.2V)/I$
R2 = (0.65V - 0.2V)) / 60nA
R2 = 0.45 V / 60nA
R2 = 7.5 MOhm

4. For the software debouncing of switch, where would you apply delay with reference to the following diagram?



A. A
B. B
C. Both A and B

D. None of the above

Explanation: Adding a delay is one of the simplest software method for debouncing a switch. The software algorithm detect the first key press, wait a while(A) and see if is still the pressed and after a certain time interval it detects the release of the key and again wait for a while(B) and see if it is still released.

5. How many microcontroller pins will be needed for interfacing 12 switches in matrix and non-matrix (individual interfacing) configuration?

   A. 12,7
   B. 7,12
   C. 8,12
   D. 12,8

Explanation: Interfacing in matrix form will require 7 pins (4*3 or 3*4 matrix) whereas interfacing each Switch individually will require 1 pin per switch i.e. 12 pins.

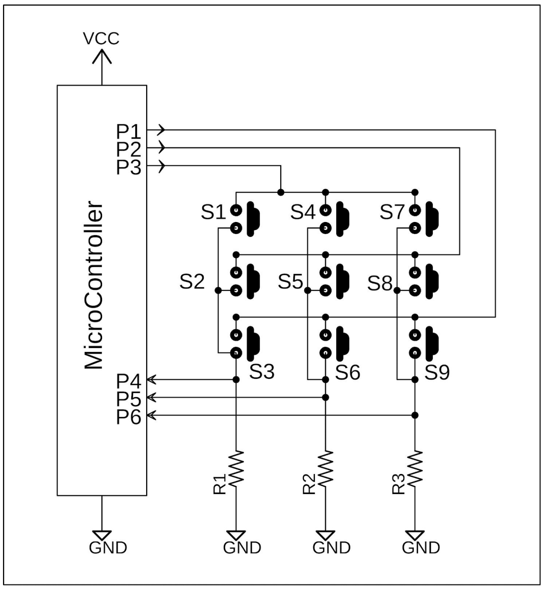
6. Which of the following is a better approach to use for interfacing switches with microcontrollers, when the number of switches to be interfaced is large in number (>8)?

   A. Interface single switch to single pin of the microcontroller in either pull-up or pull-down configuration
   B. By connecting switches in matrix form and then interfacing with the microcontroller
   C. Using an ADC of microcontroller
   D. None of the above

Explanation: Interfacing Switches in matrix form is beneficial because it requires a lesser number of pins.

7. In this figure shown below, the keypad of switches is interfaced with a microcontroller. $P_{1,}$ $P_{2,}$ P_3 are set as output and $P_{4,}$ $P_{5,}$ P_6 are set as input. If no switch is pressed, this is the process to check that:

   Step1: SET $P_{1,}$ $P_{2,}$ P_3 as LOGIC (i)__; Step 2: $P_{4,}$ $P_{5,}$ P_6 would return LOGIC (ii)__

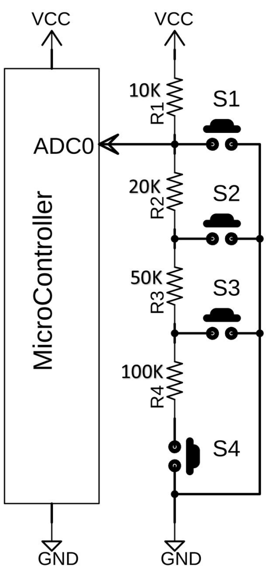


(i), (ii)

A. 1, 1
B. 1, 0
C. 0, 0
D. 0, 1

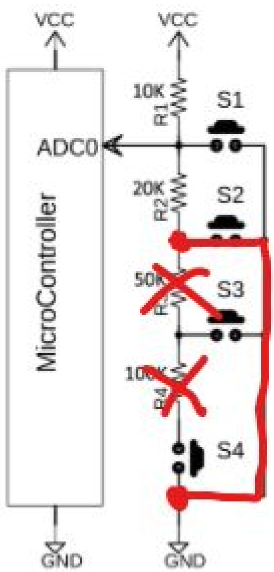
Explanation: Since pull down resistors are connected below the switches, the Pins P4, P5, P6 are going to be "0" by default. To check if any of the switches are pressed or not pressed, the output pins P1,P2,P3 have to be given logic 1. In this case, if no switch is pressed (and hence none of the connections of the vertical lines complete and hence no current flows through any of the resistors), then all the input pins P4, P5 and P6 will indicate a 0 logic level. Whereas, if any of the switches were pressed, all the pins P4, P5, P6 will not be 0.

8. In the figure shown below, what will be the input to ADC0 when switch S2 is pressed?



A. 0V
B. 2/3 * VCC

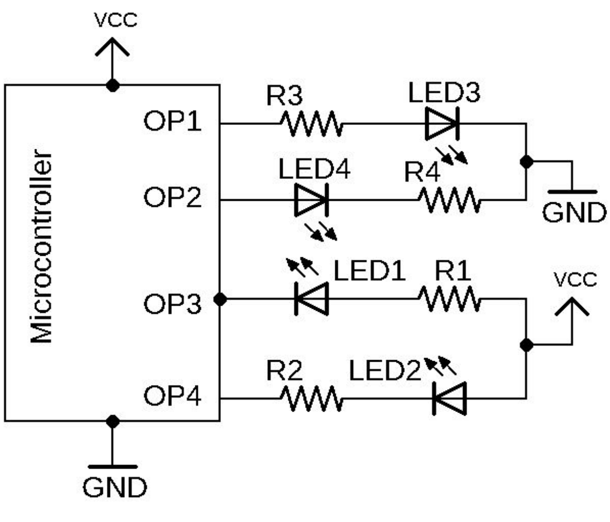
C. VCC
D. 17/18 * VCC



Explanation: After the switch is pressed the equivalent circuit will be as shown above only containing R1 and R2. therefore we can say the voltage at ADC0 is:

Vadc0= (Vcc*R2)/(R1+R2)= (Vcc* 20K)/ (10K +20K) = Vcc*(2/3)

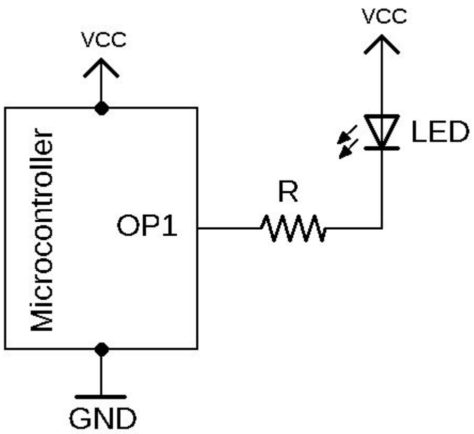
9. Mark the **CORRECT** statements for the figure given below.



A. LED 3 & 4 are identical in connection and are in active low configuration.
B. LED 1 & 2 are identical in connection and are in active high configuration.
C. LED 3 & 4 are identical in connection and are in active high configuration.
D. LED 1 & 2 are identical in connection and are in active low configuration.
E. All LEDs are connected differently.

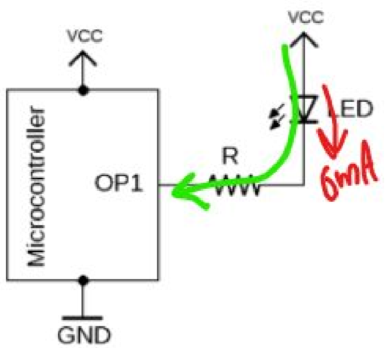
Explanation: In the Figure we can clearly see the Led 3 and 4 will be on if the microcontroller will give an output high that is when the Leds are in forward bias whereas Led 1 and 2 will be in forward bias when microcontroller gives output low.

10. For the given circuit, find the value of 'R'. Assume V_{OH}= 3.75V, V_{OL} = 0.2V, V_{LED} = 3.0V, I_{LED}=6mA, V_{CC} = 5V.



A. 300 kΩ
B. 330 Ω
C. 300 Ω
D. 330 kΩ

Explanation:
Consider the image given below.
The LED will be turned on and current will flow through it only when it is forward boased. This happens when the OP1 Pin is at Logic Low. The minimum value of Logic Low Voltage Threshold of the microcontroller Output pin is $V_{OL.}$



Therefore, Applying KVL in the path [Green]:

R = (V_{CC} - V_{LED} - V_{OL}) / I_{LED}
R= (5V - 3V - 0.2V) / 6mA
R= 1.8V/6mA
From above equation we will get R=0.3Kohms or 300 ohms