Introduction To Embedded System Design

Assignment Solutions- Week 2

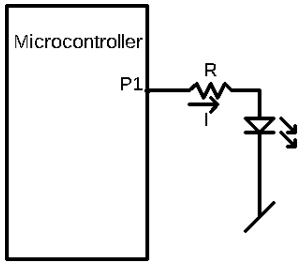
1. Which of the following functions is/are typically not expected from a microcontroller?
   (a) Read Digital Inputs
   (b) Measure time between two events
   (c) Store data
   (d) Run an operating system like Windows

Explanation: Running an entire operating system such as windows is not expected from a typical microcontroller. A general purpose computer requires an operating system.

2. Which of the following statements is FALSE about modern microcontrollers?
   (a) Pins are fully programmable, i.e. they can be configured as input or output.
   (b) Each pin offers multiple functions one of which can be selected.
   (c) Input pins can either have weak pull up, strong pull up or tri state capability.
   (d) Output pins can drive high current (more than 100 mA) loads directly.

Explanation: Output pins of a general modern microcontroller can typically source 20-30mA. So a high current(more than 100mA) load can not be connected directly to the output pins. Whereas, For saving the chip size, modern microcontroller pins are multifunctional and can be programmed as input or output according to need.They also have internal pull ups and tri-state capabilities.

3. With the data given below, guess the colour of LED.
   $V_{OH} = 4.5V$
   $V_{OL} = 0.5V$
   $I = 14mA$
   $R = 200\ ohms$



   (a) Green
   (b) Red

(c) Blue
(d) White

Explanation: To turn on the LED, the P1 output has to be set High.
As we know:
I= (Voh-Vled)/R , substituting the values of **Voh**, **I** and
R we get **Vled=1.7v** which is the forward voltage drop for RED LED.

4. Which of the following is/are TRUE about MSP430G2553?
   (a) 64 bit microprocessor
   (b) 16KB SRAM, 512B Flash
   (c) RISC architecture
   (d) Harvard Memory architecture

Explanation: MSP430 contains a 16bit RISC architecture microprocessor with 512B SRAM and 16KB Flash memory with Von neumann memory architecture.

5. What is the significance of lock in program memory of a microcontroller?
   (a) To protect the code so that it can't be rewritten.
   (b) To secure the contents of program memory so that nobody can read it.
   (c) To give access to only certain people to run the code.
   (d) All of the above.

Explanation: Locking the flash memory disallows any further programming and reading of the program memory contents.

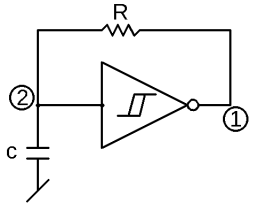
6. Which of the following is/are TRUE about "clock scalability" in a microcontroller?
   (a) It is the same as overclocking.
   (b) It means the system clock frequency can be altered at run time.
   (c) It helps in saving power.
   (d) None of the above.

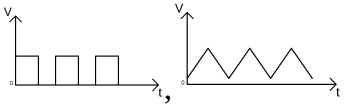
Explanation: Clock scalability simply means that for the operation of microcontroller clock frequency can be varied using inbuilt clock divider circuits. This option helps microcontrollers to work with less power dissipation (since PD $\propto$ Frequency).

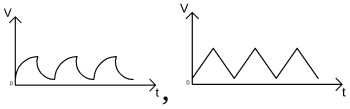
7. Suppose a microcontroller has an 8-bit timer and the clock applied to it has frequency of 10KHz with its high time as 20us. What is the maximum time that can be measured?
   (a) 5.120ms
   (b) 2.048ms
   (c) 20.480ms
   (d) 25.6ms

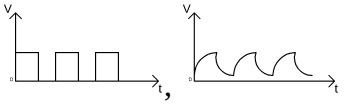
Explanation: 8 bit timer = max count of 256(i.e 0-255)
Now, f_{clk} = 10Khz
So, time period= 0.1ms
So max time that can be measured is 256 X 0.1 =25.6ms

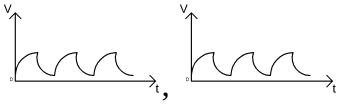
8. Which of the following correctly represents the voltage waveforms observed at node 1 and node 2 in the circuit shown below?



(a) 

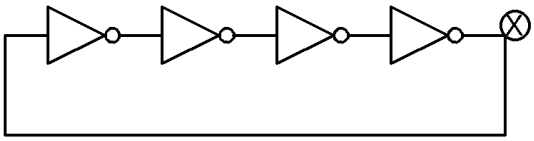
(b) 

(c) 

(d) 

Explanation: The given circuit consists of a schmitt trigger, So, the waveform 2 coming out of the schmitt trigger will be a square waveform, whereas the waveform at 1 will be a simple RC charging discharging waveform.

9. In the diagram shown below, what is the frequency of the signal generated at node X if the delay of each NOT gate is 2ns?



(a) 125 MHz
(b) 625 MHz
(c) 62.5 MHz
(d) None of the above

Explanation: If any value (0 or 1) is considered at the input of the first inverter, then the same value is present at the output of the last inverter which means all we are getting is a constant output and every wire is at a stable high or low logic. There is no oscillation and frequency=0. It is not a ring oscillator as there are even number of gates.

10. A CMOS wrist watch of resolution 1s is to be designed with the only consideration that the battery should last as long as possible. Which of the following crystals in the inventory would you choose to make it?
    (a) 32,768 Hz
    (b) 8,192 Hz
    (c) 65,536 Hz
    (d) 16,384 Hz

Explanation: In a CMOS circuit Power Dissipation $\propto$ frequency, therefore lower the frequency $\rightarrow$ lower the Power Dissipation $\rightarrow$ longer battery life.