Introduction To Embedded System Design

Assignment Solutions- Week 3

1. A microcontroller with 10 MHz clock requires 10 clock cycles to process any sample. Which analog signals with the maximum frequency component given below, can this microcontroller successfully sample?
    A. 10 Mhz
    B. 1 Mhz
    C. 600 KHz
    D. 200 KHz

Explanation:
The microcontroller requires 10 Clock cycles = 10^-6 seconds to process each sample. To successfully sample a signal having the maximum frequency component f, we need to sample it at 2f frequency. Therefore,

2f = 10^6 Hz
f = 500 KHz.

The only option lower than 500KHz is 200KHz.

2. Which of the following is/are TRUE about bootloader?
    A. It is used in In Application Programming (IAP).
    B. Bootloader program memory section communicates with the host computer to write a new program in bootloader program memory itself.
    C. It is used in In System Programming (ISP).
    D. Bootloader program memory section communicates with the host computer to write a new program in user program memory which is the bigger portion of the memory.

Explanation: The bootloader program uses In-Application Programming as it allows for the new user program to be loaded without removing the chip from the system and while the application is running. This is possible because the bootloader is located in the same memory block as the user program. And the user program is in the major portion of the same memory block. The bootloader communicates with the host computer to write the new program in the user memory after which the program counter goes to the first instruction of the new user program to be executed.

3. An 8 bit watchdog timer with a clock of frequency 10MHz is there in a microcontroller. Within what maximum time should the program reset watchdog timer before the watchdog timer resets the microcontroller?
    A. 256ms
    B. 256us
    C. 25.6ms
    D. 25.6us

Explanation:
Here the time for which the watchdog timer waits before resetting the microcontroller is asked, given:

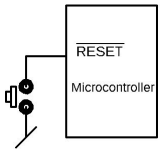
size=8 bit
Clock Frequency=10MHz

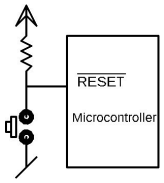
therefore **one clock pulse is of duration=1/10us=0.1us**
The maximum number upto which the **8 bit register can count is = 2^8=256**
So the **wait time=256*0.1=25.6us**

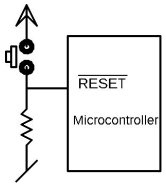
4. How do the contents of RAM get affected by Power On reset and User reset respectively?
    A. No change; No change
    B. Arbitrary values; No change
    C. No change; Arbitrary values
    D. Arbitrary values; Arbitrary values

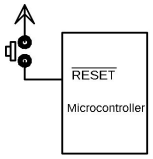
Explanation: Power-on reset is a power recycle of the system (meaning that the power is turned off and then turned on) and since the RAM Memory is volatile, the contents of the RAM will not be retained and it will have junk/arbitrary values after Power-on Reset.
User reset does not turn off the power of the system and hence the data in the RAM Memory is retained.

5. Which of the following is the best way to add a user reset switch to a microcontroller if the reset pin is active low?

A.


B.


C.


D. 

Explanation: the answer is option B. Since the reset pin is active low, the microcontroller will be reset when the pin is at 0V (low logic). The pull-up resistor on the pin ensures that the pin is at logic level high when not in use to prevent any false activation of the pin. On pressing the switch, the pin will short the pin to ground connecting it to a low logic level and this will reset the microcontroller.

6. Why do we need to reduce Quiescent Current?

    A. Lower Quiescent current directly relates to better battery life.
    B. A lot of power is wasted in linear regulators to keep them working.
    C. In No LOAD condition, Quiescent current does not need to be reduced as no load is being driven.
    D. None of the above

Explanation: Quiescent current refers to the current flowing in the circuit when it is not driving any load. Quiescent current directly translates to power consumption of the battery when there is no load. So reducing the current, reduces the power consumed by the linear regulators and thereby increases the battery life in the long term.

7. If the battery voltage is always above 3.3V and the required output voltage from a voltage regulator needs to be 3V, what sort of voltage regulators could be used?
    A. LDO
    B. Buck
    C. Boost
    D. **Buck-Boost**

Explanation: Low-Drop Out Regulators, Buck Regulators and Buck-Boost Regulators can be used to convert 3.3V to 3V. Since we want to reduce the input voltage to a lower voltage level we can’t use boost regulators.

8. A buck regulator is 95% efficient. If the output voltage is 3V, load current is 100 mA, Input voltage is 10V, what is the input current?
   A. 100 mA
   B. 110 mA
   C. 31.6 mA
   D. 316 mA

Explanation: Efficiency = Output Power/Input Power

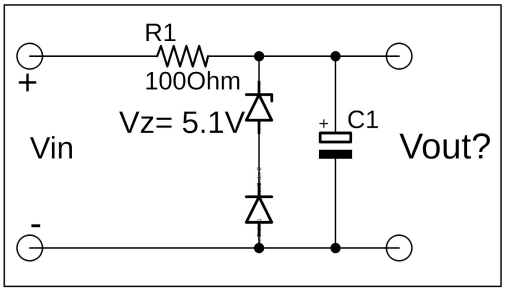
So, $Efficiency = (V(output) * I(load)) / (V(input) * I(input))$

0.95 = (3 * 0.1)/(10 * I(input))

0.95 = 0.03/ I(input)

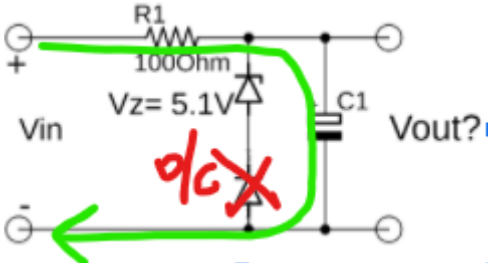
I(input) = 0.03/0.95 = 31.578 mA = 31.6 mA (approx.)

9. For the following circuit, if V(in) is 10V, what is the value of V(out)? A silicon rectifier diode is in series with the Zener diode.



   A. 10V
   B. 5.1V
   C. 5.8V
   D. 4.4V

Explanation: in the above circuit at first it may seem like a normal regulator circuit and you can get tempted to mark the output voltage=5.1v but when we look closely it can be seen that the silicon rectifier diode is in series with the zener diode and it will not pass any current through it because it is reverse biased, which means the zener branch is open and the capacitor is directly charged to 10V.



Therefore Vout=10V.

10. Which of the following is an important consideration for a battery?

A. Terminal Voltage
B. Power-to-weight ratio
C. Number of charging and discharging cycles
D. None of the above

Explanation: To define the usage of battery it is important to know the terminal voltage since only a fixed voltage can be used for an application.
Power-to-weight ratio is also an important metric while selecting the battery as it helps characterise the performance of a battery independent of its size. Number of charging and discharging cycles is an important factor to determine the life of the battery.