

Assignment 4

MCQ:

1. On the basis of power consumption, choose the correct option.

- A. CMOS sensor > CCD sensor
- B. CMOS sensor < CCD sensor
- C. CMOS sensor = CCD sensor
- D. None of the above.

Solution: Option A. CMOS sensor > CCD sensor

Explanation: We can put logic on the chip in CMOS sensors which increases the power consumption of the system. On the other hand, CCD sensors do not have logic embedded in them.

2. I am building a device that takes in digital signals but restricts the input below a certain frequency limit. What kind of filter should I use in the device?

- A. High pass filter
- B. Low pass filter
- C. Both A and B
- D. None of the above

Solution: Option B. Low pass filter

Explanation: A low pass filter allows the passage of signals below a set frequency. High pass filters allow the passage of signals above a set frequency.

3. An operational amplifier has

- A. Very low input impedance and infinite output impedance
- B. Infinite input impedance and infinite output impedance
- C. Infinite input impedance and very low output impedance
- D. Very low input impedance and very low output impedance

Solution: Option C. Infinite input impedance and very low output impedance

Explanation: This is a property of operational amplifiers which make them voltage gain devices.

4. The number of comparators needed in a flash A/D convertor for a 5 bit conversion is

- A. 30
- B. 31
- C. 32
- D. 33

Solution: Option B. 31

Explanation: Number of convertors needed for a flash A/D convertor for n bit conversion is $2^n - 1$. For n=5, the number of converters is $32 - 1 = 31$.

5. Calculate the resolution(in mV) for a 8-bit A/D convertor over a voltage range of 15V.

- A. 17066.67
- B. 58.60
- C. 58.82
- D. None of the above

Solution: Option C. 58.82

Explanation: $\text{Res}(Q)$ for n-bit convertor = $V/(2^n - 1)$

Putting $n=8$, $V=15$, $\text{Res}(Q) = 15/(2^8 - 1) = 0.05882V = 58.82\text{mV}$

6. Which of the following properties of the Nyquist criteria are true?

- A. Sampling frequency must be at least twice that of the highest frequency in the signal.
- B. Frequency spectrum gets divided into an infinite number of Nyquist zones each having a width of half the sampling frequency.
- C. Both A and B
- D. None of these.

Solution: Option C. Both A and B.

Explanation: Option A is the definition of Nyquist criteria. Option B says about the Nyquist bandwidth which is equal to half the sampling frequency.

7. Quantization is a _____ process.

- A. Linear
- B. Reversible
- C. Irreversible
- D. None of these

Solution: Option C. Irreversible

Explanation: Quantization is a many to one mapping, hence cannot be reversed.

8. In an Arduino processor there is separate storage for data and instructions.

- A. True
- B. False

Solution: Option A. True

Explanation: An Arduino processor is built on Harvard architecture.

9. Which algorithm is used in Successive-approximation A/D Convertor?

- A. Linear Search
- B. Binary Search
- C. Both A and B
- D. None of the above

Solution: Option B. Binary Search

Explanation: Successive approximation A/D Convertor uses a binary search with weights to convert the continuous analog signal to digital.

10. Which of the following properties of the Pulse Width Modulation(PWM) are true?

- A. PWM decreases the overall heating of the device.
- B. PWM regulates the average power applied to a device by varying the DC.
- C. Both A and B
- D. None of the above.

Solution: Option C. Both A and B

Explanation: PWM varies the DC thereby forming duty cycles. This helps regulate the average power applied at an instant and hence reduce the external factors like heating.

Short-Answer type(Alphanumeric answers only):

11. What is the quantization error(in mV) for a 6-bit convertor running over 10V?(upto 2 decimals)

Solution: 79.37

Explanation: Res(Q) for n-bit convertor = $V/(2^n - 1)$; Quantization error(e) = Q/2

Putting n=8, V=15, Res(Q) = $10/((2^6 - 1)) = 0.15873V$; e = $0.079365V = 79.37mV$.

12. Calculate the nyquist rate(in Hz) for the given continuous signal
 $x(t) = 2\cos(30\pi t) + 3\sin(50\pi t) - 6\cos(68\pi t)$

Solution: 68

Explanation:

$$f_1 = 30\pi/2\pi = 15\text{Hz}$$

$$f_2 = 50\pi/2\pi = 25\text{Hz}$$

$$f_3 = 68\pi/2\pi = 34\text{Hz}$$

Therefore, $f_{\max} = 34\text{Hz}$

By Nyquist criteria, $f_s = 2*f_{\max} = 2*34 = 68\text{Hz}$.