CSE 350
Spring 2024
Quiz 04

Total Marks: 20 **Time: 15 minutes**

Name:	St. ID:	Section:	Serial Number (From the Attendance Sheet)

You have to send a confidential voice message (analog signal) to your friend via an optical fiber. For this, first, you have to convert your message (into a digital signal) so that it can be transmitted through the fiber. The **maximum and minimum values of your original message are 0V and +10V, respectively.** Your friend has a digital signal receiver that can handle a **maximum of 2% of quantization error** and has a **binary-weighted DAC circuit (where, R = 20 kOhm, R_F = 10 kOhm, and Vref = -10V)** to convert the received digital signal into an analog signal.

Q#1.[CO3] Calculate the **minimum number of bits** required in this case. [5]
Q#2.[CO3] Calculate the **number of resistors** required in this case if you use **a flash ADC** circuit. [5]
Q#3.[CO3] Calculate the **number of OP-AMPs** required in this case if you use **a flash ADC** circuit. [5]
Q#4.[CO3] If your friend receives **01101**, what will be the value of the **converted analog signal in voltage?** [5]

Q.1

$$\% \text{ of quantization error} = \frac{\Delta Q}{|V_{max} - V_{min}|} \times 100$$

$$2 = \frac{\Delta Q}{|V_{max} - V_{min}|} \times 100$$

$$N = 4.64$$

$$\therefore \boxed{N = 5}$$

$\Delta Q = \frac{1}{2}\Delta$ [ΔQ = quantization error]

$\Delta = \frac{V_{max} - V_{min}}{L}$ [Δ = resolution]

$L = 2^N$ [L = number of levels]

N = number of bits

Q.2

For flash ADC

$$\#\text{ Resistor} = 2^N = 2^5 = \boxed{32}$$

Q.3

$$\#\text{ op-amp} = (2^N) - 1 = 2^5 - 1 = \boxed{31}$$

Q.4

For DAC,

$$V_o = -V_{ref} \times \frac{R_f}{R}\left[b_5 + \frac{b_4}{2} + \frac{b_3}{4} + \frac{b_2}{8} + \frac{b_1}{16}\right]$$

$$= -(-10) \times \frac{10}{20}\left[0 + \frac{1}{2} + \frac{1}{2} + 0 + \frac{1}{16}\right]$$

$$\Rightarrow \boxed{V_o = 9.0625\,V}$$

$$\left[\begin{array}{l} b_5 = MSB \\ b_1 = LSB \end{array}\right]$$