Problems

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1. Convert the numbers 1/8 and -1/8 into sign magnitude, one's and two's complement form.

Answer :

Sign Magnitude:	1/ 8	=	0.001
	-1/8	=	1.001
One's Complement:	1/ 8	=	0.001
	-1/8	=	1.110
One's Complement:	1/ 8	=	0.001
	-1/8	=	1.110

2. Convert the numbers 5,-5, 0.125 and -0.125 into floating point number.

Answer:

$$5_{10} = 2^{11_2} 0.1010$$

$$-5_{10} = 2^{11_2} 1.1010$$

$$0.125_{10} = 2^{-10_2} 0.1000$$

$$-0.125_{10} = 2^{-10_2} 1.1000$$

3. Form the sum 0.53125 + (- 0.40625) using one’s and two’s complement addition assuming a wordlength of 5 bits.

Answer:

One’s Complement:

0.10001 + 1.10010 = 10.00011, carry is added to the LSB, hence the result is 0.00100.

Two’s Complement:

0.10001 + 1.10011 = 10.00100, carry is discarded hence the result is 0.00100.

4. Form the sum 7/8+4/8+(-6/8) using 2's complement addition. Assume a wordlength of 3 bits.

Answer:

7/8 + 4/8 = 0.111+0.100 =1.011

11/8 – 6/8 = 1.011+ 1.010 = 0.101

5. Find the steady state output noise power due to quantization at the output of the digital filter. The impulse response of filter is $\mathbf{h(n)=(0.6)^n u(n)}$

Assume the input is quantized to 4 bit(3 b, 1 sign bit)

Answer:

$$\boldsymbol{\sigma_y^2 = 0.09765}$$

6. The output signal of an ADC is passed through a first order lowpass filter, with the transfer function given by

$$H(z) = \frac{(1-a)}{1-az^{-1}}$$

Find the steady state output noise power due to quantization at the output of the filter.

Answer:

$$\sigma_y^2 = \frac{2^{-2b}}{2}\left(\frac{1-a}{1+a}\right)$$

7. Consider the transfer function $H(z)=H_1(z)\ H_2(z)$ where .

$$H_1(z) = \frac{1}{1-0.5z^{-1}} \ \& \ H_2(z) = \frac{1}{1-0.6z^{-1}}$$

Determine the output noise power assuming the bits are rounded to 3 bits.

Answer:

$$\sigma_y^2 = 7.072 \times 10^{-3}$$

8. For the second order system given as

$$H(z) = \frac{1}{1 - 2r\cos\theta z^{-1} + r^2 z^{-2}}$$

Find the steady state output noise variance.

Answer:

$$\sigma_y^2 = \frac{2^{-2b}}{2}\left(\frac{1+r^2}{(1-r^2)(1-2r^2\cos 2\theta + r^4)}\right)$$

9. Determine the deadband of the first order system characterized by the difference equation, $y(n)=-0.5\,y(n-1)+0.875\,\partial(n)$. Assume the data register length is 3 bits plus one sign bit.

Answer:

Deadband ≤ 0.125

10. Given $$\mathbf{H(z) = \frac{0.5 + 0.4\,z^{-1}}{1 - 0.312 z^{-1}}}$$

is the transfer function of a digital filter. Find the scaling factor S_0 to avoid overflow in adder 1 of the digital filter.

Answer:

$S_0 = 0.9501$