Đinh Hoàng Sang - BEBEIU17022.

Homework 2.

⑤ Slide 20:

Kirchoff's Current Law, we have:

$i = i_1 + i_2 + \dots + i_n$.

$$\Rightarrow \frac{v_0 - 0}{R_f} = \frac{0 - v_1}{R_1} + \frac{0 - v_2}{R_2} + \dots + \frac{0 - v_n}{R_n}$$

$$\Rightarrow \frac{v_0}{R_f} = \frac{-v_1}{R_1} + \frac{-v_2}{R_2} + \dots + \frac{\cancel{0} - v_n}{R_n}$$

$$\Rightarrow v_0 = -\left(\frac{v_1 R_f}{R_1} + \frac{v_2 . R_f}{R_2} + \dots \frac{v_n R_f}{R_n}\right)$$

① Slide 21.

Two more type of D/A converter circuit:

+ The serial digital to analog converter
+ BCD digital converter.
+ Digital to Analog Converter (Bipolar.) with the weighted resistor method, R2R.

⑤ Question 1

$SNR_{dB} = 10 dB = 20 \log \left(\frac{V_{signal}}{V_{noise}}\right)$.

$\cdot V_{noise} = 0.5$.

$\Rightarrow V_{signal} = 1.58$ volts rms $\Rightarrow V_{pp} = 2\sqrt{2}\, V_{signal} = 2\sqrt{2} \cdot 1.58 = 4.47\ (V)$.

① Question 2.

$v_n = \sqrt{4 K T R B}$

$$\Rightarrow R = \frac{v_n^2}{4 . K T B} = \frac{(10^{-5})^2}{4 \cdot 1.38 \cdot 10^{-23} \cdot 310 \cdot 10^3}$$

$= 5.84 \cdot 10^6 \Omega$.

$$\Rightarrow I_n = \frac{V_n}{R} = \frac{10^{-5}}{5.84 \cdot 10^6} = 1.7 . 10^{-2}$$

① Question 3:

$v_n = \sqrt{4 K T R B} \Rightarrow B = \frac{v_n^2}{4 K T R} = \frac{(1.5 \cdot 10^{-6})^2}{1.32 \cdot 10^{-23} \cdot 310 \cdot 1\dots}$

$= 132\ Hz$.

Question 4

a) We have: $I_{total} = [(i_d^2 + i_a^2 + i_r^2)]^{\frac{1}{2}}$.

$\cdot\ i_d = \sqrt{2 \times q \cdot I_D \cdot B} = 9.986 \cdot 10^{-13} (A)$

$\cdot\ i_n = \sqrt{4 KTB / B.} = 4 \cdot 1.37 \cdot 10^{-12} (A)$.

$\cdot\ i_a = i_{n\,relative} \cdot \sqrt{B} = 0.01 \cdot 10^{-12} (A / \sqrt{Hz}) \cdot \sqrt{10 \cdot 10^5 (Hz)}$

$= 10^{-12}\ (A)$

$\Rightarrow I_{total} = 4.372 \cdot 10^{-12}\ (A)$.

(b) $SNR_{dB} = 10 \log (SNR) = 20 \log \left(\frac{I_{rms\ signal}}{I_{rms\ noise}}\right)$.

$$\Rightarrow I_{rms\ sinal} = I_{rms\ noise} \cdot 10^{\frac{SNR_{dB}}{20}} = 7.775 \cdot 10^{-12}$$

$$\Rightarrow \Phi_{min} = \frac{I_{rms\ signal}}{Senitivity} = \frac{7.775 \cdot 10^{-12}}{0.3 (\mu A / \mu W)} = \frac{7.775 \cdot 10^{-12}}{0.3} = 2.592 \cdot 10^{-11} W$$

Question 5:

Attenation $= -20\,(n\text{-}poles) \log \left(\frac{f_2}{f_1}\right)$

$= 20 \log 85.$

$\Rightarrow -20\,(n\text{-}poles) \log \left(\frac{10}{106}\right) = 38.5.$

$$\Rightarrow n\text{-}poles = \frac{38.5}{-20 \log \left(\frac{1}{10}\right)} \approx 2\ poles$$

$= 20 \cdot d$

$\approx 6.02.$

Problem 7:

$$\sigma^2 = \frac{V_{max}^2}{12(2^n-3)} = \frac{10^2}{12(2^8-3)} = 0.0327$$

$\cdot V_{noise} \simeq \sigma = \sqrt{0.0327} = 0.18$ volts

$\cdot SNR = \frac{2}{0.18} \simeq 11.11$

$\Rightarrow SNR_{dB} = 10 \log(11.11^2) = 20.9 \, dB.$