Analog Signal Processing
Class-Test-3

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Q1. $V_{rms} = \frac{V_{p-p}}{2\sqrt{2}} = \frac{225\, mV}{2\sqrt{2}}$

~~SNR FULL =~~

$V_{LSB} = \frac{V_{ref}}{2^N} = \frac{5}{2^{18}}\, V.$

$V_{Q}(RMS) = \frac{V_{LSB}}{\sqrt{12}} = \frac{5}{2^{18} \times \sqrt{12}}\, V.$

$SNR_{full} = \frac{225 \times 10^{-3}}{2\sqrt{2} \times \frac{5}{2^{18} \times \sqrt{12}}} = \cancel{14.109}\ 225.7449$

$SNR(in\, dB) = 20 \log\left(\cancel{14.109}\ 225.7449\right) dB$

$= 47.07\, dB$

Q2. $V_{out} = \frac{1}{sC_F}\left(\frac{V_{ref}\, sC}{2} + \frac{V_{ref}\, sC}{4} + \frac{V_{ref}\, sC}{8} + \frac{V_{ref}\, sC}{16}\right)$

$\Rightarrow V_{out} = -\frac{V_{ref}C}{sC_F}\left[\frac{1}{2} + \frac{1}{4} + \frac{1}{8} + \frac{1}{16}\right]$

$\Rightarrow \frac{V_{out}}{V_{ref}} = 1$

$C_F = C \times \frac{15}{16} =$

Q3.

$FSR = 4.8\,V.$

$$V_{out} = R\left[b_0 \times \frac{I}{2} + b_1 \frac{I}{4} + b_2 \frac{I}{8} + \dots b_7 \times \frac{I}{128}\right].$$

When FSR,

$$4.8 = R \times I \times \left[1 + \frac{1}{2} + \frac{1}{4} + \dots \frac{1}{128}\right].$$

$$4.8 = R \times I \times \frac{\left(\frac{1}{2}\right)^8 - 1}{\left(\frac{1}{2} - 1\right)}.$$

$$4.8 = 9.83 \times 10^3 \times I \times \frac{1 - \left(\frac{1}{2}\right)^8}{\frac{1}{2}}.$$

$$I = 259.07\,\mu A.$$

Q4.

$$\frac{C}{16} = \frac{1}{\frac{1}{C_S} + \frac{1}{2C}}.$$

$$\Rightarrow \frac{1}{C_S} + \frac{1}{2C} = \frac{16}{C}.$$

$$\Rightarrow \frac{1}{C_S} = \frac{16}{C} - \frac{1}{2C} = \frac{31}{2C}.$$

$$\Rightarrow C_S = \frac{2C}{31} = 14.258\,pF.$$

$$\simeq 14.26\,pF$$

Q5.

$\omega_{out} = \omega_0 + K_{V_{CO}} V_{cont}$.

$21 \times 10^3 = 20 \times 10^3 + 6.9 \times V_{cont} \times 10^3$.

$\Rightarrow V_{cont} = \frac{10}{69}$ V. $= 0.1449$ V.

Q6.

$f_{osc} = \frac{1}{2Nt_d}$

$= \frac{1}{2 \times 3 \times 228 \times 10^{-12}}$ Hz

$= 730.994$ MHz.

Q7.

$V_{LSB} = \frac{V_{ref}}{2^N}$.

$\Rightarrow N = \log_2 \frac{V_{ref}}{V_{LSB}}$

$= \log_2 \frac{5}{10^{-3}}$.

$= 12.287$

$\boxed{N = 13}$ → resolution.

Q8.

DNL can be calculated using adjacent diff between levels.

Q9: Here,

$$\cancel{\frac{V_{REF}}{4R} \times kR = R_1\left(\frac{V_{in}+V_{REF}}{R+R_1}\right) - V_{REF}}$$

$$\cancel{V_{in}} \qquad \cancel{R_1 V_{in}}$$

For LHS,

Voltage at (-ve) terminal for both opamps. (in terms of resistor).

$$V^- = \frac{V_{REF}}{4R} \times kR$$

$$= \frac{V_{REF}k}{4}.$$

For RHS,

voltage at -ve terminal

$$= R_1\left(\frac{V_{IN}+V_{REF}}{R+R_1}\right) - V_{REF}$$

$$= \frac{R_1 V_{IN} - R V_{REF}}{R+R_1}.$$

(1) $\frac{V_{REF} \cdot k}{4} \geq V_{IN} \Rightarrow 0.$ else, 1

(2) $R_2 V_{IN} - R V_{REF} \geq 0 \Rightarrow 0.$ else, 1.

$$R_2 V_{IN} \geq R V_{REF}$$

$$\frac{V_{IN}}{V_{ref}} \geq \frac{R}{R_2} = \frac{k}{4}$$

$$R_2 = \frac{4R}{k}$$

for $R_1 \Rightarrow k = 3.$

$$R_1 = \frac{4R}{3}$$

$$R_2 = \frac{4R}{2}$$

$$R_3 = \frac{4R}{1}$$