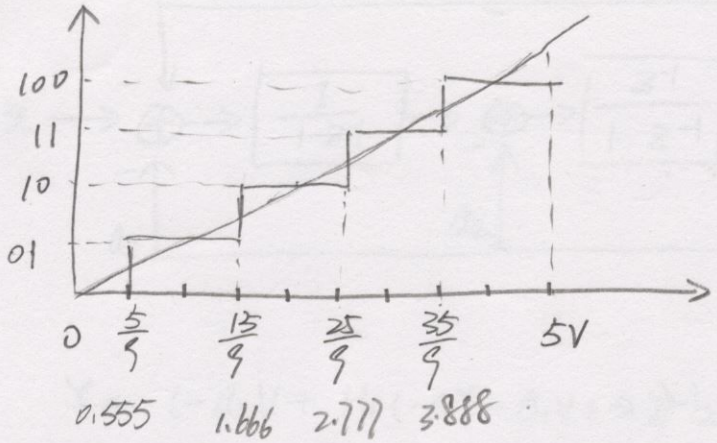
① keXu

a.



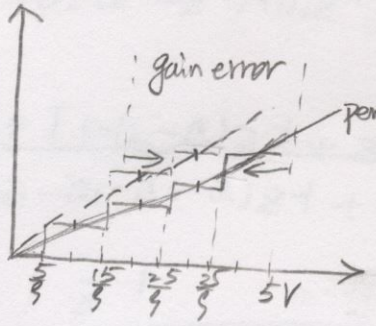
5-level unipolar mid tread.
there are 4 opportunities
and there are 9 steps.
transition voltage is shown
on the plot.

b. If there must not be any missing codes in output. missing code occurs if $V_n < V_{n-1}$ which may occurs if $2|V_{os}|_{max} > V_{LSB}$
Hence. to avoid it $|V_{os}|_{max} < \frac{V_{LSB}}{2} \cong 0.555V$

c. $DNL = |V_{os,n}| + |V_{os,n-1}| = 2|V_{os}|_{max} = V_{LSB} = \frac{10}{9}V \cong 1.11V$.

d. offset error: $E_{off(A/D)} = \frac{V_{00\ldots1}}{V_{LSB}} - \frac{1}{2}LSB = \frac{1}{2}V_{LSB}$.
deviation from $1/2\,V_{LSB}$.

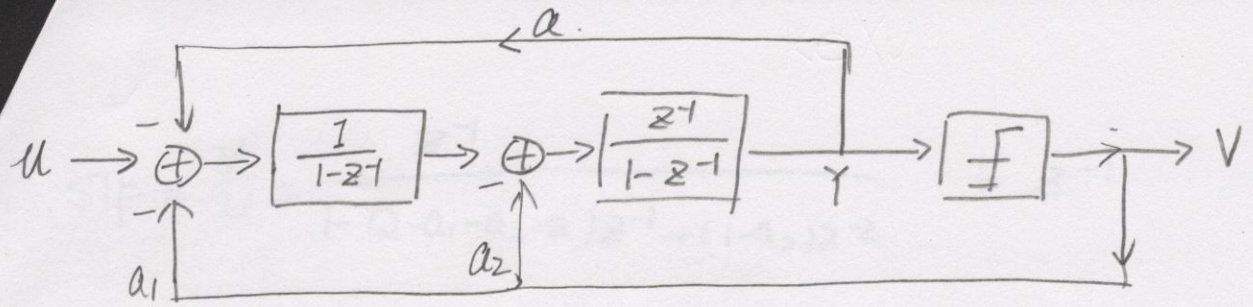
Gain error:



$\frac{35}{9} - \frac{25}{9} = \frac{10}{9} = V_{LSB}$.

$\therefore E_{gain(A/D)} = V_{LSB}$.

e. $INL \cong \frac{V_{LSB}}{2}$.



a.

$$Y = (-a_2V + H_1(-aY - a_1V + u))H_2 = (-a_2V + H_1u - a_1VH_1 - aYH_1)H_2$$

$$\therefore Y = \frac{H_2(H_1u - a_2V - a_1VH_1)}{1 + aH_1H_2}$$

$$V = Y + E = \frac{H_2(H_1u - a_2V - a_1VH_1)}{1 + aH_1H_2} + E$$

$$= E + \frac{z^{-1}u - a_2V(z^{-1} - z^{-2}) - a_1Vz^{-1}}{(1-z^{-1})^2 + az^{-1}}$$

$$= \frac{E[(1-z^{-1})^2 + az^{-1}] + z^{-1}u}{(1-z^{-1})^2 + az^{-1}} - \frac{a_2V(z^{-1} - z^{-2}) + a_1Vz^{-1}}{(1-z^{-1})^2 + az^{-1}}$$

$$V \cdot [(1-z^{-1})^2 + az^{-1} + a_2(z^{-1} - z^{-2}) + a_1z^{-1}] = E[(1-z^{-1})^2 + az^{-1} + z + u$$

$$\therefore V = \frac{z^{-1}u + [1 - (2-a)z^{-1} + z^{-2}] \cdot E}{1 - (2 - a_1 - a_2 - a)z^{-1} + (1 - a_2)z^{-2}}$$

$$STF = \frac{V}{U} = \frac{z^{-1}}{1 - (2 - a_1 - a_2 - a)z^{-1} + (1 - a_2)z^{-2}}$$

$$NTF = \frac{V}{Q} = 1 - (2 - a)z^{-1} + z^{-2}$$

$$STF = \frac{V}{U} = \frac{z^{-1}}{1-(2-a_1-a_2-a)z^{-1}+(1-a_2)z^{-2}} = z^{-1}$$

$$\begin{cases} 1-a_2 = 0 \\ 2-a_1-a_2-a = 0 \end{cases} \Rightarrow \begin{cases} a_2 = 1 \\ a_1+a = 1 \end{cases}$$

$$NTF = 1-(2-a)z^{-1}+z^{-2} = 1-1.95z^{-1}+z^{-2}$$

$$\begin{cases} 2-a = 1.95 \\ a_1+a = 1 \end{cases} \Rightarrow \begin{cases} a = 0.05 \\ a_1 = 0.95 \end{cases}$$

c.

$$NTF = 1-1.95z^{-1}+z^{-2} = \frac{z^2-1.95z+1}{z^2}$$

pole: $z^2 = 0 \Rightarrow z_p = 0$.

zero: $z^2-1.95+1 = 0 \Rightarrow z_z = \frac{1.95 \pm \sqrt{1.95-4}}{2}$

$$= 0.975 \pm j0.222$$