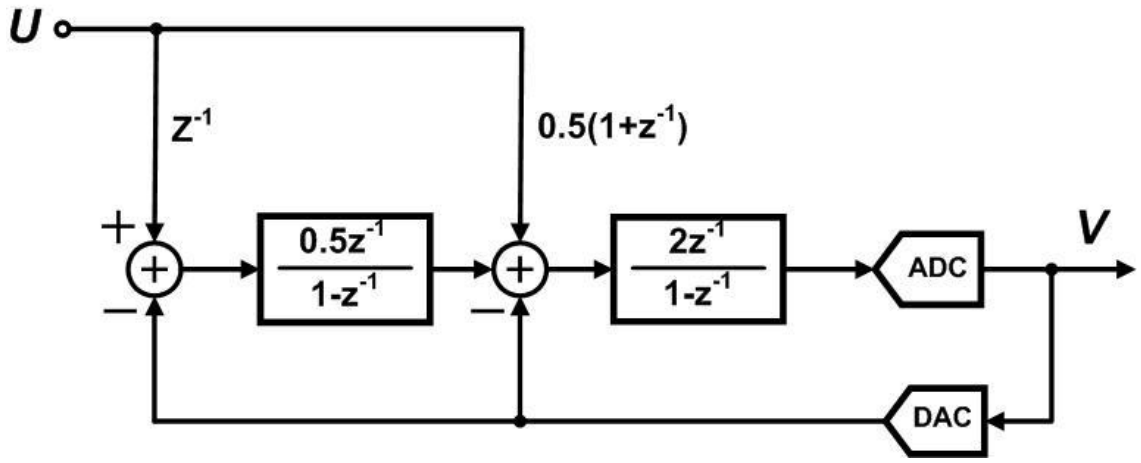
ECE 627 Spring 2010

FINAL EXAMINATION
June 11, 2010
Open book

Name: _____

2. In the delta-sigma ADC shown, the quantizer has 17 levels. The reference voltage is 2 V.
   a. Find the STF and NTF of the ADC.
   b. How large can the output of the first integrator be?
   c. Estimate the largest input voltage for guaranteed absolute stability of the loop.



2. a.

$$V = \left\{(Uz^{-1} - V)\left(\frac{0.5z^{-1}}{1-z^{-1}}\right) + U[0.5(1+z^{-1})] - V\right\}\left(\frac{2z^{-1}}{1-z^{-1}}\right) + E$$

$$\Longrightarrow V = Uz^{-1} + E(1-z^{-1})^2$$

$$STF = z^{-1}$$

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

b.

$$V_1 = \left(\frac{0.5z^{-1}}{1-z^{-1}}\right)(Uz^{-1} - V)$$

$$\Longrightarrow V_1 = -\frac{1}{2}z^{-1}(1-z^{-1})E$$

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

$$V_{LSB} = \frac{2\,V}{16\,steps}$$

$$|E| < \frac{1}{2}V_{LSB} = \frac{1}{16}V$$

$$|V_1|_{max} = \frac{1}{2}|E| + \frac{1}{2}|E| = |E|$$

$$|V_1|_{max} = \frac{1}{16}\,V$$

c.

$$V_2 = V - E = Uz^{-1} + E(1-z^{-1})^2 - E$$

$$\Rightarrow V_2 = z^{-1}U + E(z^{-2} - 2z^{-1})$$

Because $V_2 < 2 + \left(\frac{1}{2}V_{LSB}\right) = \frac{33}{16}\,V$

and $|E(z^{-2} - 2z^{-1})| < \frac{3}{16}\,V$,

$$U_{max} = (V_2)_{max} - 3|E| = \frac{33}{16} - \frac{3}{16}\,V$$

$$U_{max} = \frac{15}{8}\,V$$