EE 435

Lecture 34

DAC Design

R-String DAC Design
Discussion of Pelgrom 10-Bit String DAC
R-String DAC

Basic R-String DAC
R-String DAC

- R-String DAC with MOS switches

**Possible Limitations:**

- Switch impedance is not 0
- Switch may not even turn on at all if $V_{REF}$ is large
- Switch impedance is input-code dependent
- Time constants are input-code dependent
- Transition times are previous-code dependent

$C_L$ has $2^n$ diffusion capacitances so can get very large

- Mismatch of resistors
  - local random variation
  - gradient effects
- Decoder can get very large for $n$ large

Routing of the $2n$ switch signals can become very long and consume lots of area
R-String DAC

Review from last lecture.

V_{REF}

X_{IN}^{n}

Decoder

b_{3} \quad \overline{b}_{3} \quad b_{2} \quad \overline{b}_{2} \quad b_{1} \quad \overline{b}_{1}

R-String

Tree Decoder

V_{OUT}
R-String DAC

Assume all C’s initially with 0V
Red denotes $V_3$, black denotes 0V, Purple some other voltage
R-String DAC

\[ V_{OUT} \quad V_{DD} \]

Decoder

\[ b_3 \quad \overline{b_3} \quad b_2 \quad \overline{b_2} \quad b_1 \quad \overline{b_1} \]

Tree Decoder

Tree-Decoder in Digital Domain

Review from last lecture.
R-String DAC

- Review from last lecture.
R-String DAC

String DAC with interpolator
String DAC with “cartwheel” interpolator

Sometimes termed sub-divider, sub-range or dual-string DAC
R-String DAC

Buffered Interpolator
R-String DAC

String DAC with Coarse-String Compensation Resistors
R-String DAC

\[ X_{\text{IN}} \]

\[ n = n_1 : n_2 \]

Interpolator Loading Eliminated/Reduced with Current Biasing
R-String DAC

String DAC with Row/Column Decoders