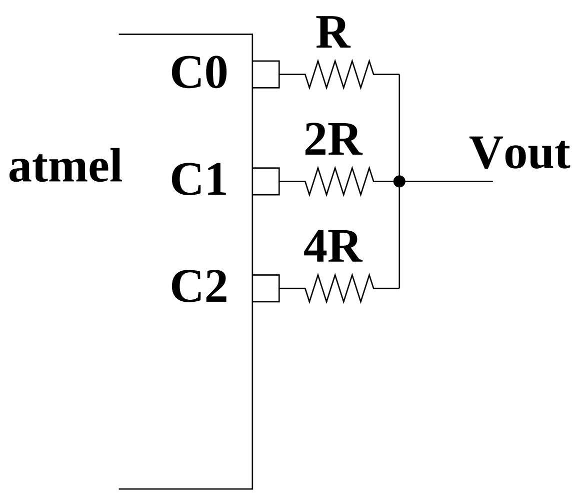
Embedded Real-Time Systems (AME 3623)
Quiz 2 Solutions

April 26, 2007

Given the following circuit of a digital-to-analog converter:



What is V_{out} as a function of digital values C_0, C_1, and C_2? Assume that the C_i is a digital value (0 or 1), and that the current down the V_{out} leg of the circuit is zero.

Ohm's Law gives us:

$$\begin{aligned} 5C_0 - V_{out} &= RI_0 \\ 5C_1 - V_{out} &= 2RI_1 \\ 5C_2 - V_{out} &= 4RI_2 \end{aligned}$$

Kirkoff's Current Law gives us:

$$\sum_{j=0}^{2} I_j = 0$$

Combining these equations gives us:

$$\sum_{j=0}^{2} \frac{5C_j - V_{out}}{R2^j} = 0$$

Therefore:

$$\begin{aligned} V_{out} &= \frac{5\sum_{j=0}^{2} \frac{C_j}{2^j}}{\sum_{j=0}^{2} \frac{1}{2^j}} \\ &= \frac{5}{7}(4C_0 + 2C_1 + C_2) \end{aligned}$$

(note that C_0 is the "most significant bit" (it affects V_{out} the most of all the bits)