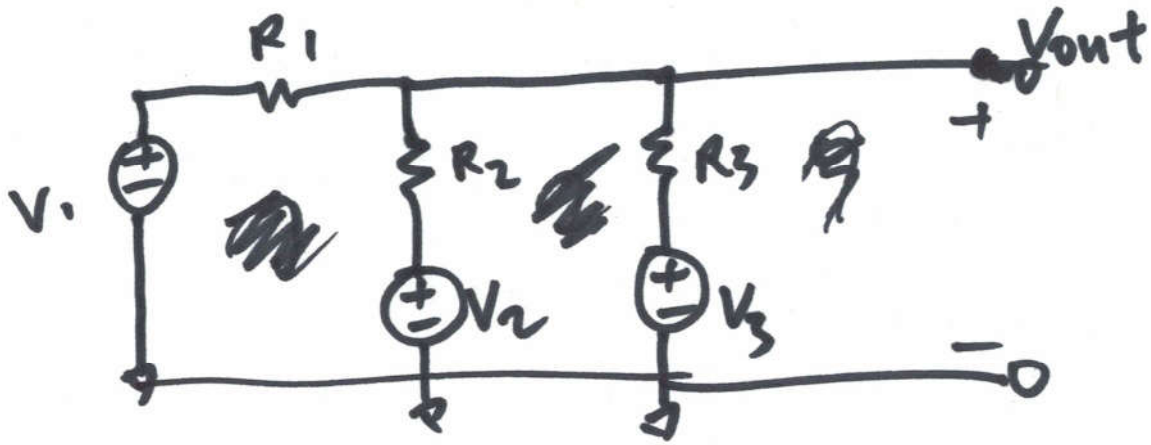
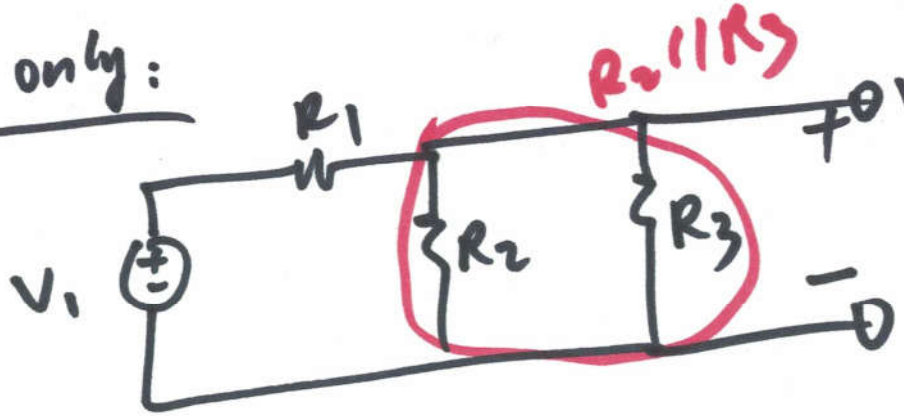
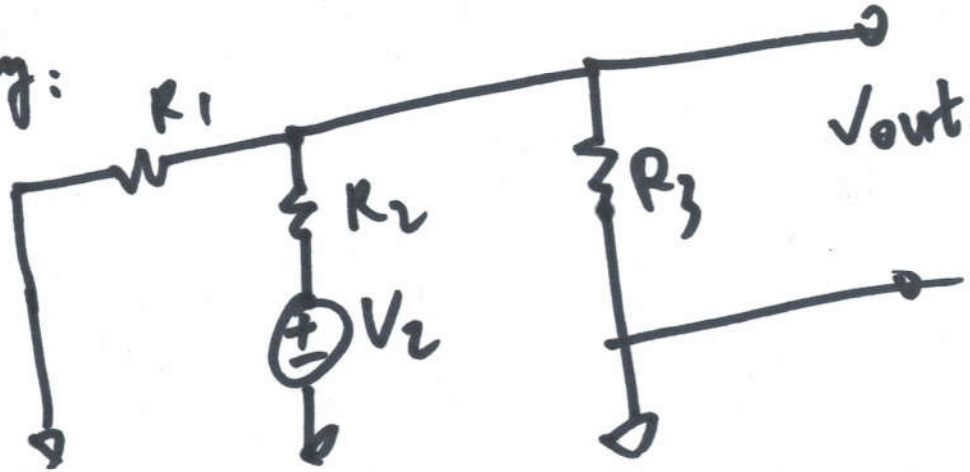


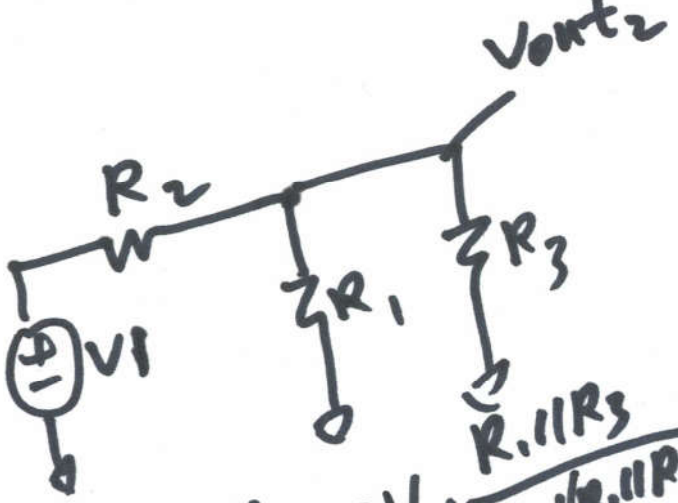
V1 only:



$$V_{out_1} = V_1 \cdot \frac{R_2 \| R_3}{R_1 + (R_2 \| R_3)}$$

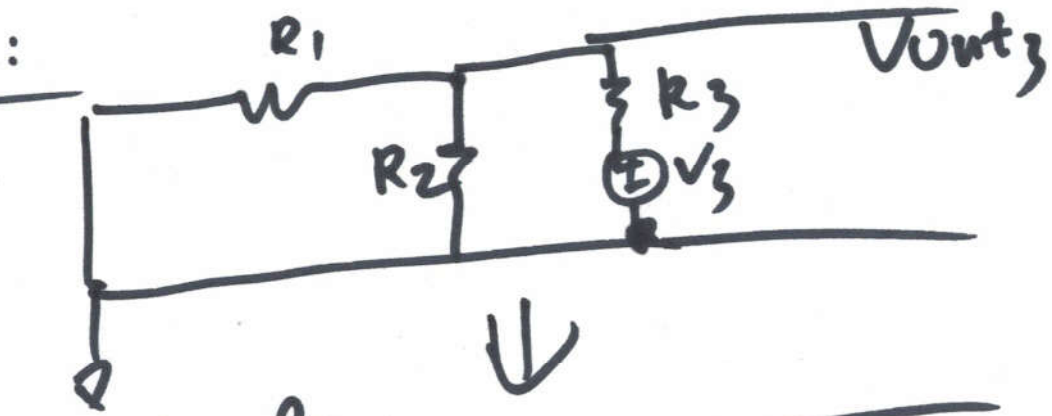
V2 only:

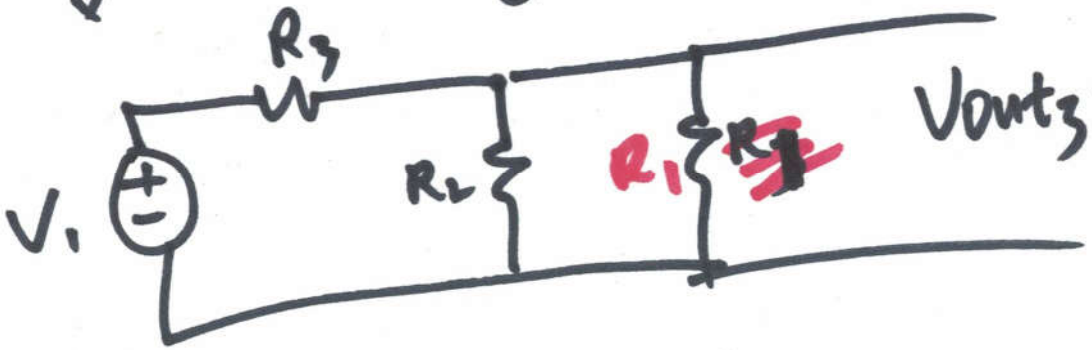




$$V_{out_2} = V_1 \cdot \frac{R_1 \| R_3}{R_2 + (R_1 \| R_3)}$$

V_3 only:



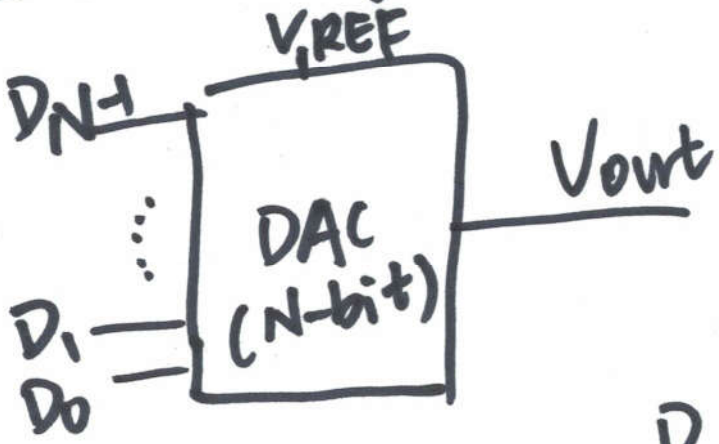


$$V_{out3} = V_1 \cdot \frac{R_1 // R_2}{R_3 + (R_1 // R_2)}$$

Finally, $V_{out} = V_{out1} + V_{out2} + V_{out3}$

$$= V_1 \cdot \left(\frac{R_2 // R_3}{R_1 + (R_2 // R_3)} + \frac{R_1 // R_3}{R_2 + (R_1 // R_3)} + \frac{R_1 // R_2}{R_3 + (R_1 // R_2)} \right)$$

△ DAC Diagrams



△ F: Fraction $F = \frac{D}{2^N}$ (D is the input word)

$$\boxed{V_{out} = V_{REF} \cdot F = V_{REF} \cdot \frac{D}{2^N}}$$

△ Example: 3-bit DAC, input $100_{(2)}$, $V_{REF} = 5V$.

Vout?

$$V_{out} = 5V \cdot \frac{100_{(2)}}{2^3} = 5V \cdot \frac{4}{8} = 2.5V$$

$100_{(2)}$: $1 \cdot 2^2 + 0 \cdot 2^1 + 0 \cdot 2^0$

△ Input range of a 3-bit DAC: 000 → 111
so the maximum output of it is: $V_{FS} = \frac{2^N - 1}{2^N} \cdot V_{REF}$

△ Find the resolution for a DAC if the output voltage is desired to change in 1mV increments while using a reference of 5V.

$$\frac{5V}{2^N} = 1mV$$

$$2^N = 5000$$

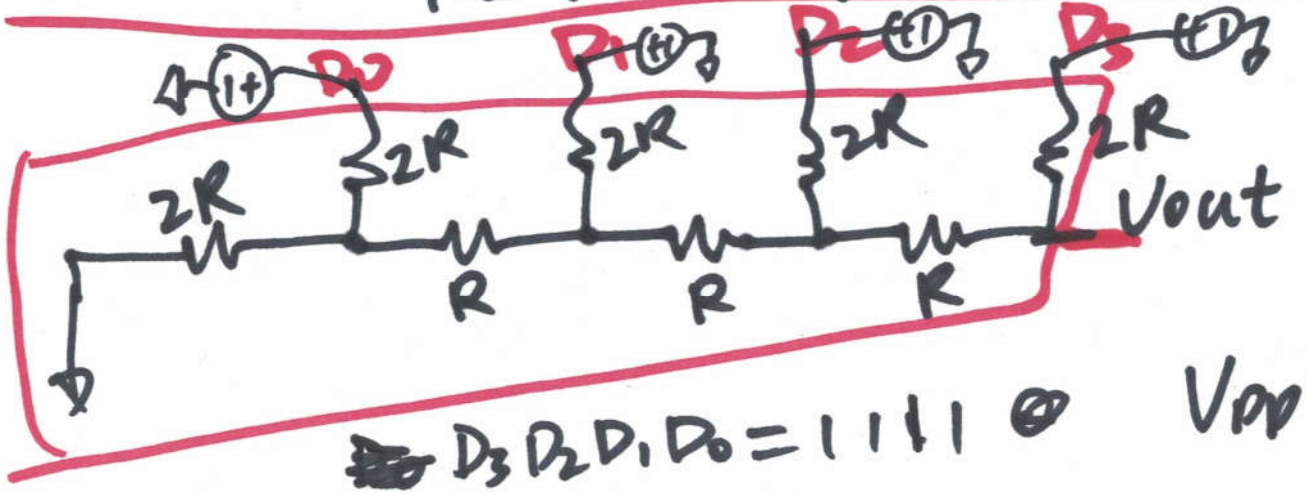
$$\log_2 2^N = \log_2 5000$$

$$N = \log_2 5000 = 12.29 \text{ bits}$$

13 bits are needed.

(4)

The R-2R ladder (R-2R DAC)



$D_3 D_2 D_1 D_0 = 1111$ @ $V_{DD} = 1$