Electrical Engineering

Electronics and Communication Engineering

Digital Electronics

Lecture No.-03

DAC & ADC

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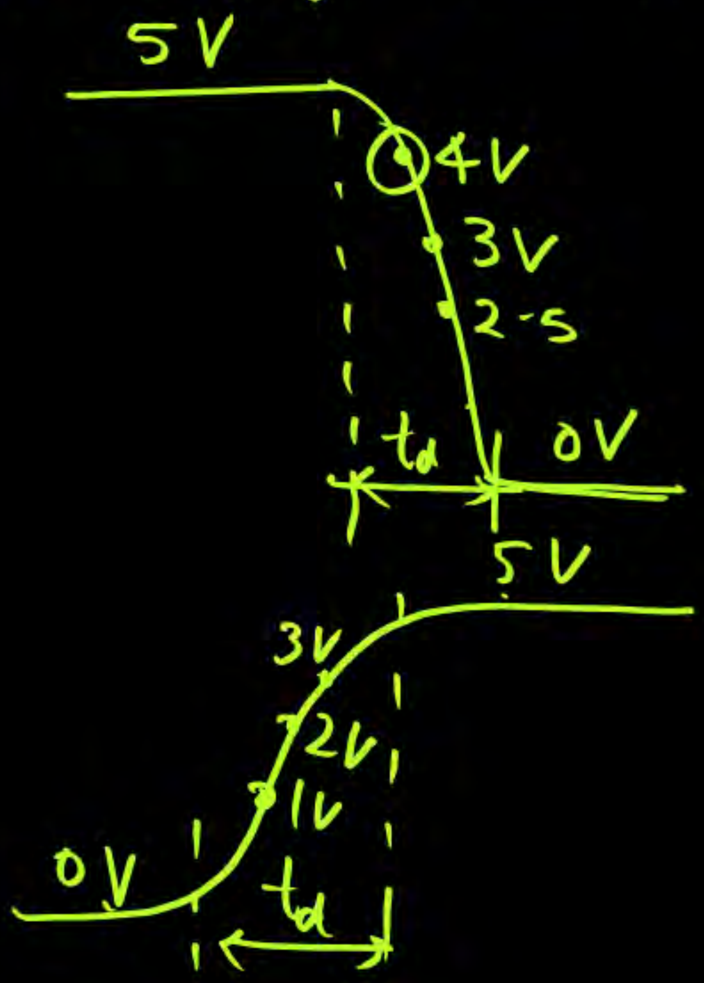
- DAC. Cont.
- Questions discussion on DAC.

Inverted Ladder

Why inverted ladder in place normal ladder ?

- In Normal ladder when digital i/p changes, due to switching delay we get transient error in the o/p before getting the actual or steady state o/p. To remove this error we use inverted ladder.



$b_2 \to 5V \longrightarrow 0V$

$b_1 \to 0V \longrightarrow 5V$

$b_0 \to 5V \to 5V$

$b_2\, b_1\, b_0$

$101 \longrightarrow \frac{5}{8} \times 5$ Vol

$b_2 \longrightarrow 5V$

$b_1 \longrightarrow 0V$

$b_0 \longrightarrow 5V$

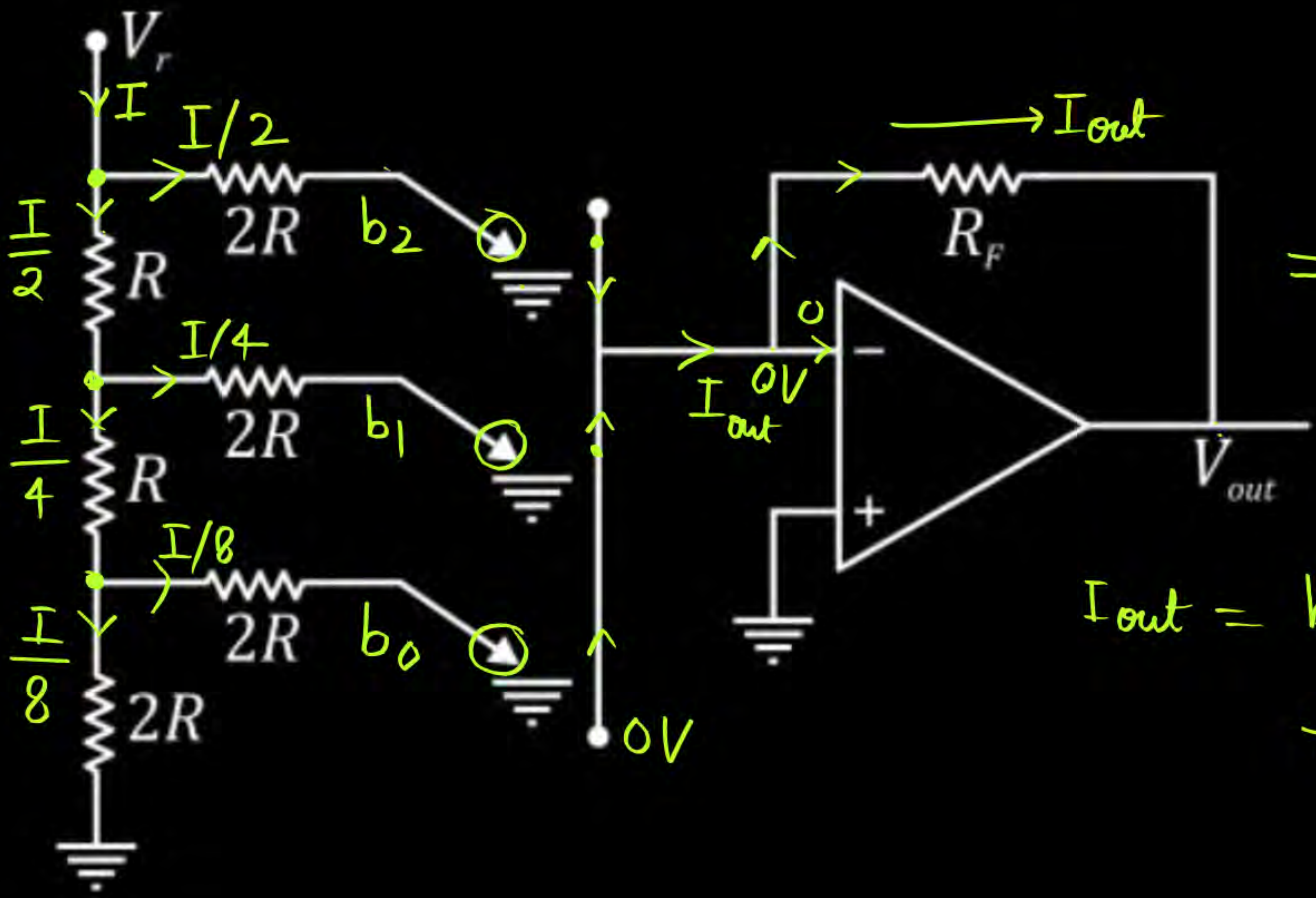
$\longrightarrow \frac{25}{8V} \times A$

011

$\frac{5}{8} \times 3 = \frac{15}{8} \times A$

Circuit :

$n = 3$ bits



$$\Rightarrow \frac{0 - V_{out}}{R_F} = I_{out}$$

$$V_{out} = -I_{out} R_F$$

$$I_{out} = b_2 \cdot \frac{I}{2} + b_1 \frac{I}{4} + b_0 \cdot \frac{I}{8}$$

Working :

$$I_{out} = \frac{I}{8}\left[2^2 b_2 + 2^1 b_1 + 2^0 b_0\right]$$

$$\frac{I}{2} = \frac{V_r - 0}{2R} \Rightarrow I = \frac{V_r}{R}$$

$$I_{out} = \frac{1}{R}\frac{V_r}{8}\left[\text{decimal equivalent of i/p digital data}\right]$$

$$\boxed{\begin{aligned} I_{out} &= \frac{1}{R} \times \text{Resolution} \times \text{decimal equivalent of i/p digital data} \\ V_{out} &= -\frac{R_F}{R} \times \text{Resolution} \times \text{decimal equivalent of i/p digital data} \end{aligned}}$$

$$\text{Resolution} = \frac{V_r}{2^n}$$

Question

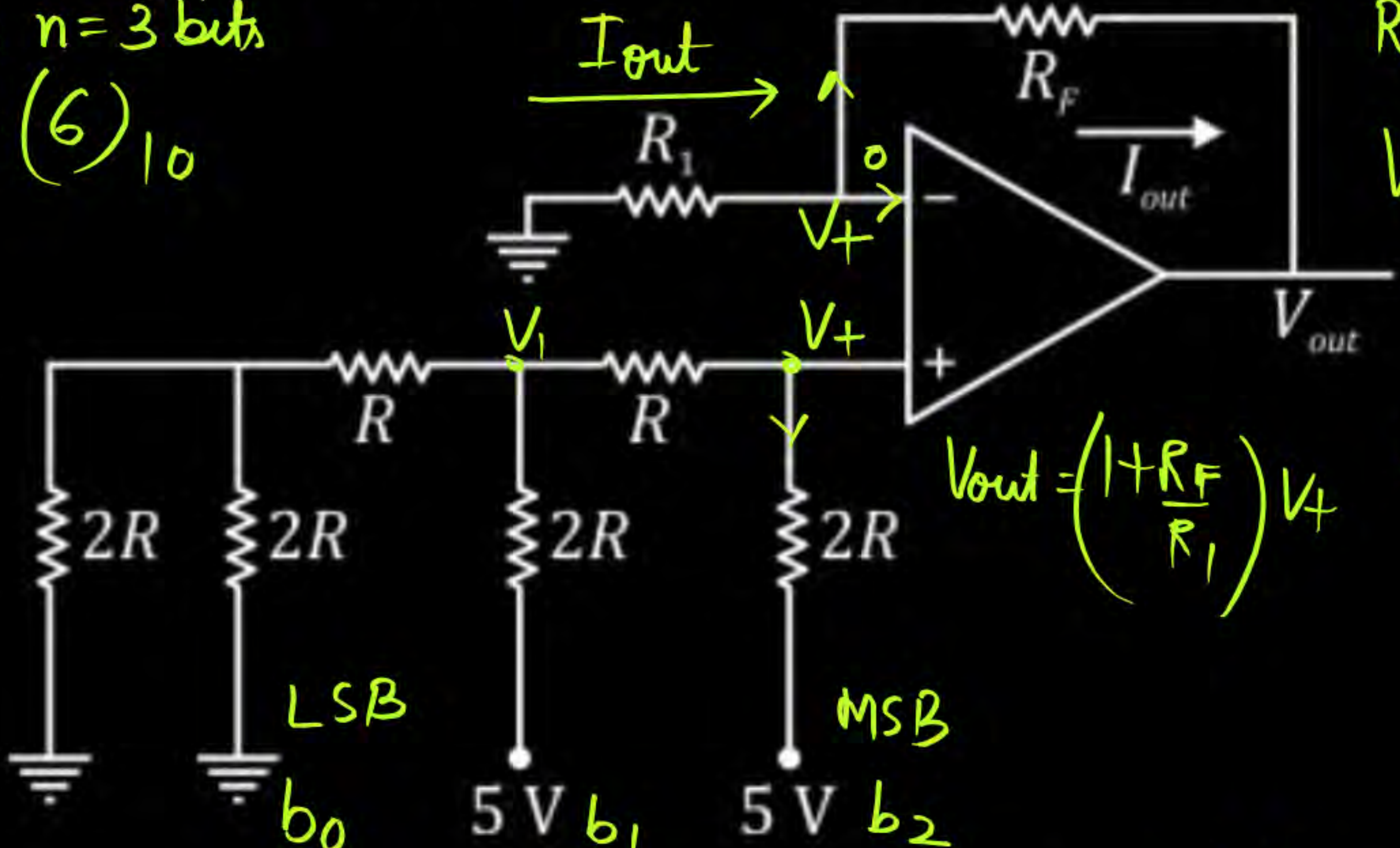
A digital to analog converter circuit is as given below :

$b_2\, b_1\, b_0 \longrightarrow n = 3$ bits

$1\ \ 1\ \ 0 \longrightarrow (6)_{10}$

$V_R = 5\,V$

I.



$V_{out} = \left(1 + \frac{R_F}{R_1}\right) V_+$

Resolution $= \frac{V_R}{2^n} = \frac{5}{8}$ Volt

$V_+ =$ Resolution $\times$ decimal equivalent

$= \frac{5}{8} \times 6 = \frac{15}{4}\,V$

$I_{out} = \frac{0 - V_+}{R_1}$

$= \frac{-15/4}{1.5}$

$= -\frac{5}{2} = -2.5\,mA$

(a) Value of output current I_{out} if $R_1 = 1.5\ k\Omega$ $\underline{-2.5}$ (mA).

(b) Value of output voltage V_{out} if $R_1 = 2\ k\Omega$ and $R_F = 3\ k\Omega$ $\underline{9.375}$ volts.

(b) $V_{out} = \left(1 + \frac{R_F}{R_1}\right) V_+ = \left(1 + \frac{3}{2}\right) \cdot \frac{15}{4} = \frac{5}{2} \times \frac{15}{4} = \frac{75}{8}$ Volt.

Question

A digital to analog converter circuit is as given below :

$R = 1K\Omega, 2R = 2K\Omega$

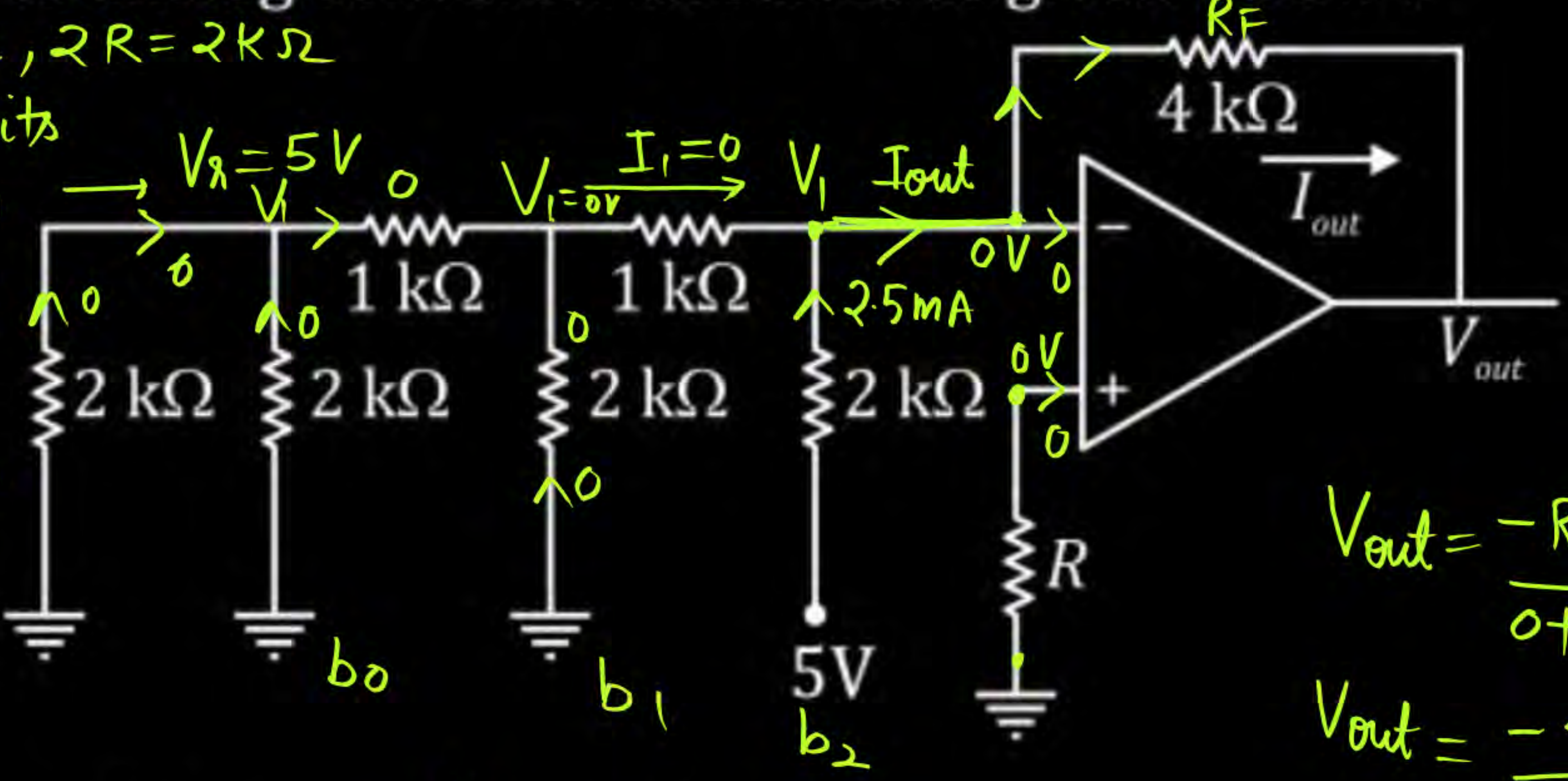
$n = 3$ bits

$b_2 b_1 b_0$

$1\ 0\ 0$

$\Downarrow$

$(4)_{10}$



Resolution $= \frac{V_R}{2^n}$

$= \frac{5V}{2^3}$

$= 5/8$ Volt

$V_{out} = \frac{-R_F}{0+R} \times$ Resolution $\times$ decimal equivalent

$V_{out} = \frac{-4}{1} \times \frac{5}{8} \times 4$

$= -10V$

$I_{out} = \frac{0 - V_{out}}{R_F} = \frac{10}{4} = 2.5mA$

(a) Value of V_{out} is <u>−10</u> volts.

(b) Value of I_{out} is <u>2.5</u> mA.

Question

In digital to analog converter circuit shown in figure below $V_R = 10$ V and $R = 10$ kΩ.

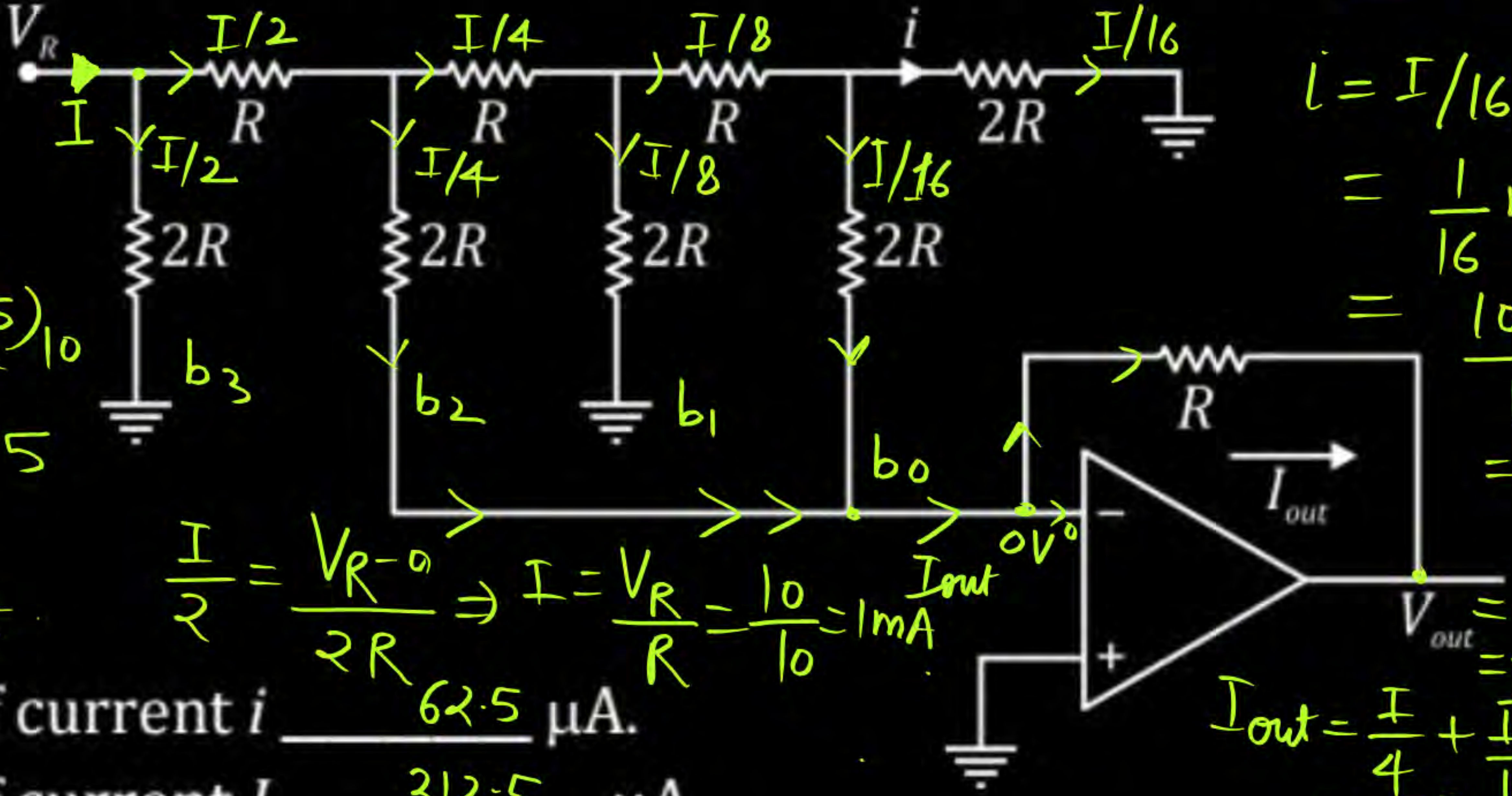
$n = 4$ bits

$b_3\ b_2\ b_1\ b_0$

$\Rightarrow 0\ 1\ 0\ 1 = (5)_{10}$

$V_{out} = -\frac{R}{R}\frac{10}{2^4} \times 5$

$= -50/16$ Volt



$\frac{I}{2} = \frac{V_R - 0}{2R} \Rightarrow I = \frac{V_R}{R} = \frac{10}{10} = 1\text{mA}$

$i = I/16$

$= \frac{1}{16}$ mA

$= \frac{1000}{16}$ μA

$= 62.5$ μA

$V_{out} = -R_f I_{out}$

$= -10 \times 0.3125$

$= -3.125$ V

$I_{out} = \frac{I}{4} + \frac{I}{16}$

$= \frac{5I}{16} = 5 \times 62.5$

$I_{out} = 312.5$ μA

- The value of current i ___62.5___ μA.
- The value of current I_{out} ___312.5___ μA.
- The value of output voltage V_{out} ___−3.125___ Volts.

Thank you

GW

Soldiers !