Homework 7.1

Homework due Sep 1, 2022 23:59 +06 Completed

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HW 7.1.1

5.0/5.0 points (graded)

An analog signal in the range $1V$ to $15V$ is to be converted to a digital signal with a quantization error of less than or equal to 0.098% for midtread quantization. The quantization error is the maximum error occur after quantizing the analog signal.

What is the required number of bits for this?

9

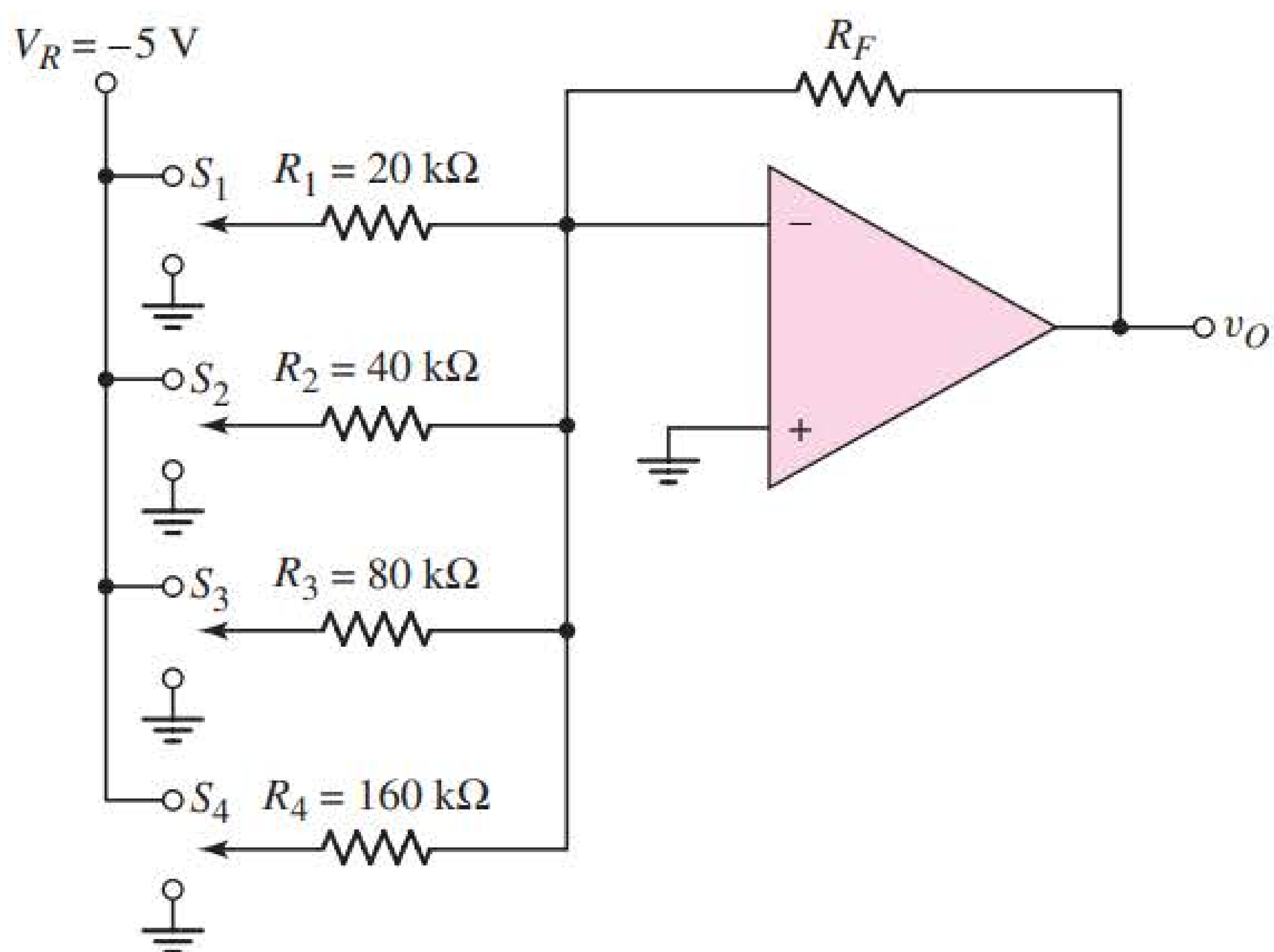
9

Save

Submit You have used 2 of 3 attempts

HW 7.1.2

10.0/10.0 points (graded)



What is the output voltage of the 4-bit weighted-resistor D/A in the above if the input is 0101? Assume $R_F = 10k\Omega$.

What is the output v_o in V?

1.5625

1.5625

What is the maximum allowed tolerance ($\pm$ percent) in the value of R_1 so that the maximum error in the output is limited to $\pm\frac{1}{2}LSB$ quantized voltage value?

5.8823

5.8823

Save

Homework 7.2

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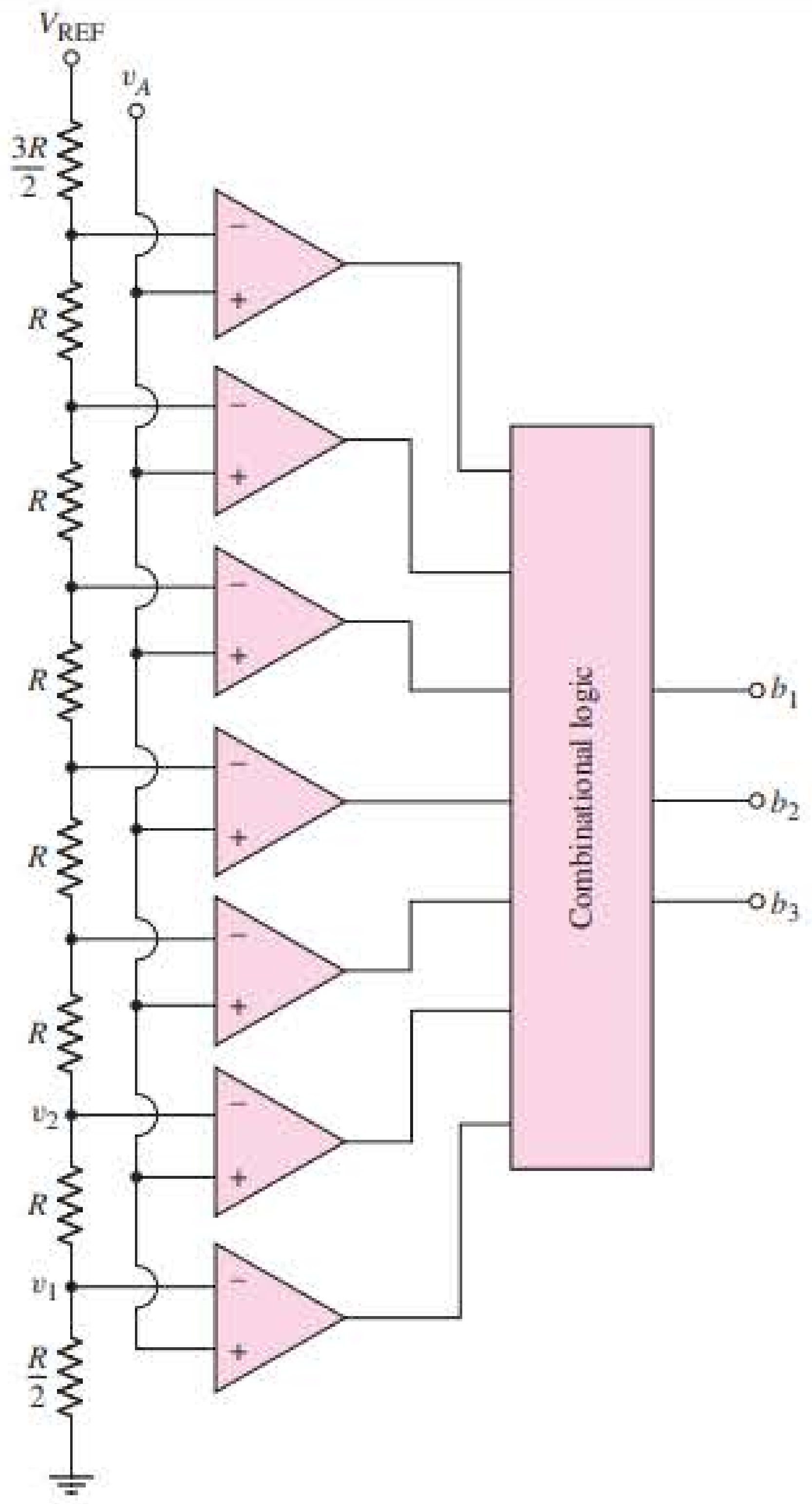
HW 7.2.1

6.0/6.0 points (graded)



The 3-bit flash A/D converter in the above figure has a reference voltage of $V_{REF} = 11V$. Here the 3-bit output is 110.

What is the min value of v_A that produces this output?

7.5625

7.5625

What is the max value of v_A that produces this output?

8.9375

8.9375

Submit You have used 1 of 3 attempts

HW 7.2.2

4.0/4.0 points (graded)

A 6-bit flash A/D converter, similar to the one in earlier question, is to be fabricated.

How many resistors are required?

64

64

How many comparators are needed?

63

63

Homework 7.3

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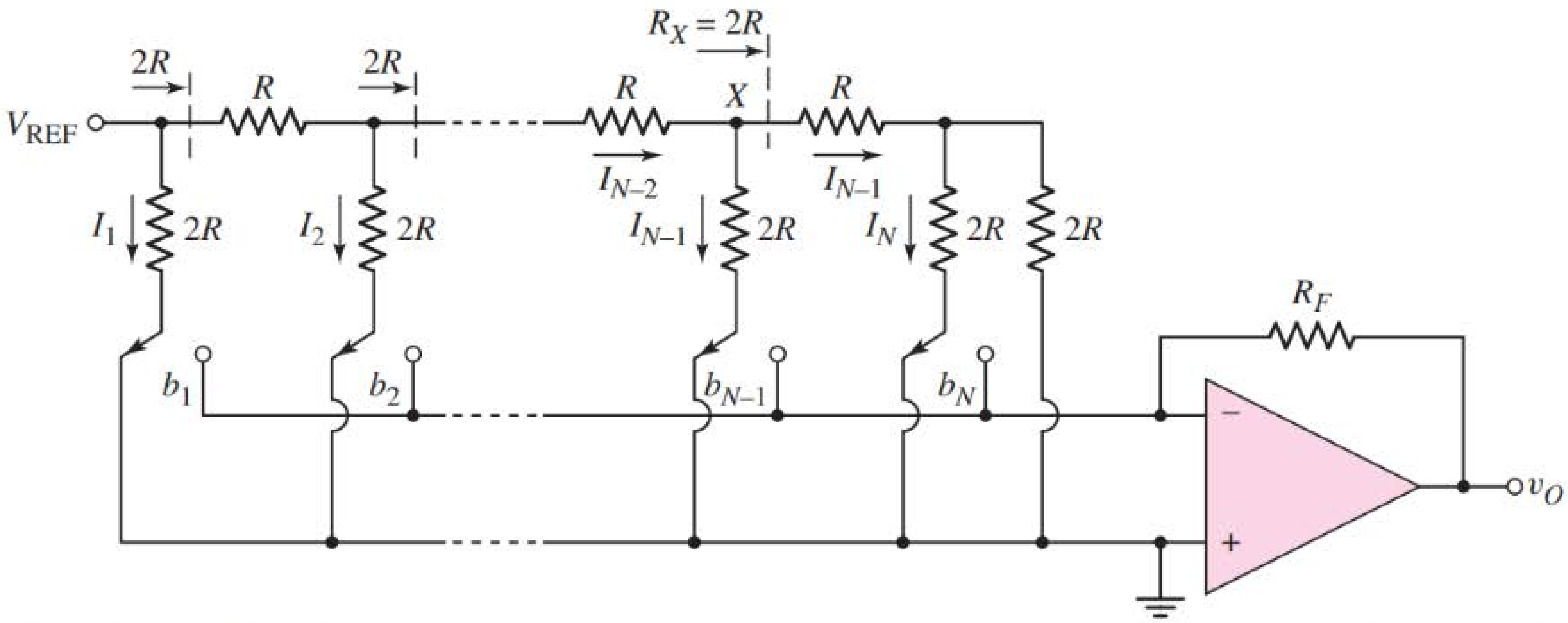
HW 7.3.1

5.0/5.0 points (graded)



The N-bit D/A converter with an R–$2R$ ladder network in the above figure is to be designed as a 8-bit D/A device. Suppose $V_{REF} = -8V$.

What is the change in output voltage if the input changes from 01001010 to 00010000?

-3.625 V ✔

-3.625

Submit You have used 3 of 3 attempts

HW 7.3.2

5.0/5.0 points (graded)

A 8-bit successive approximation A/D converter has an analog input in the range $0 \leq v_A \leq 8V$ and has a clock frequency of $2MHz$.

What is the maximum conversion time?

4.5 μs ✔

4.5

Homework 7.4

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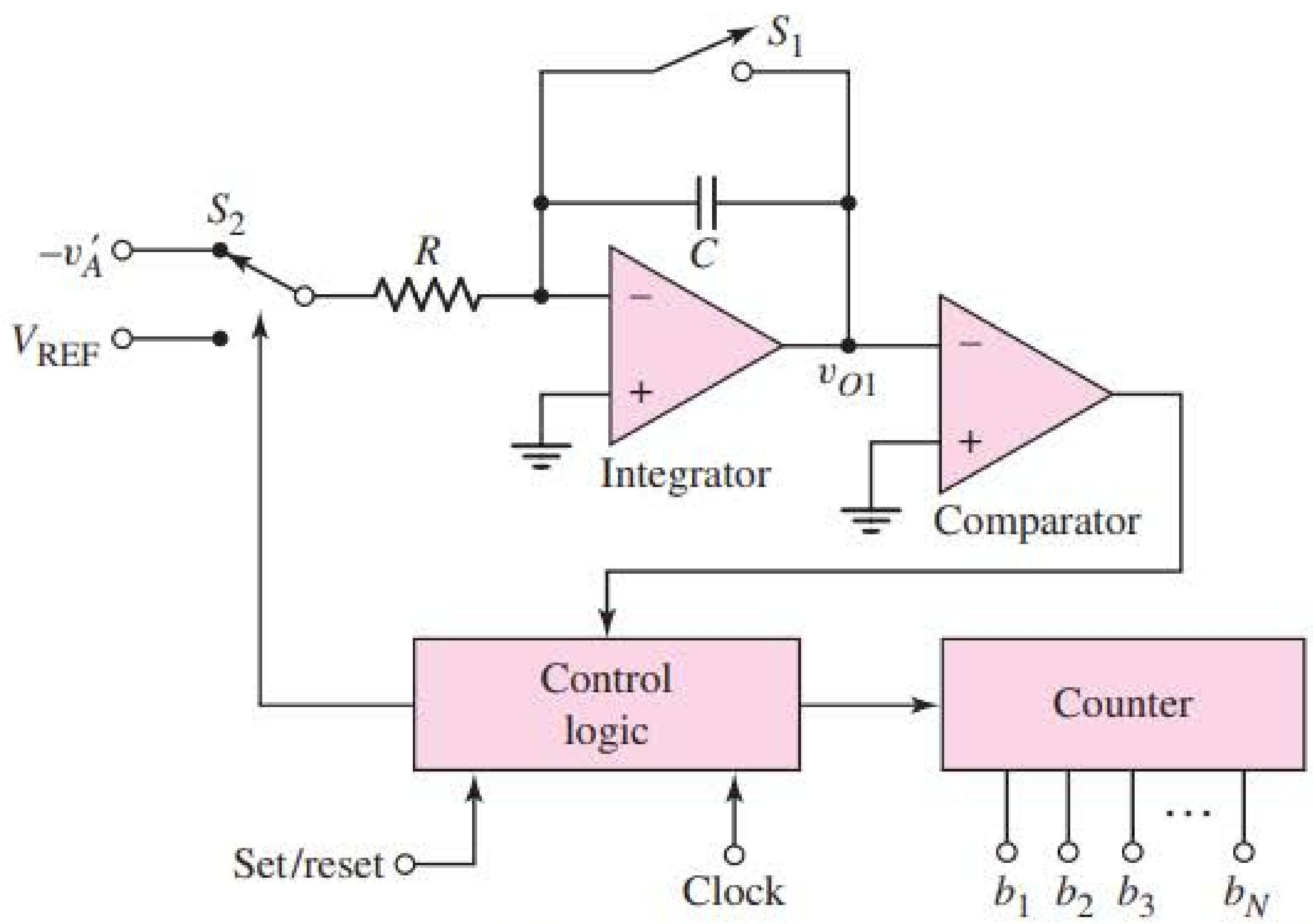
HW 7.4.1

0/15 points (graded)



The above figure is to be designed as a 6-bit A/D device. Suppose $V_{REF} = 4V$ and Clock time period $1\mu s$.

What is the output digital output if $v'_A = 0.4000V$?

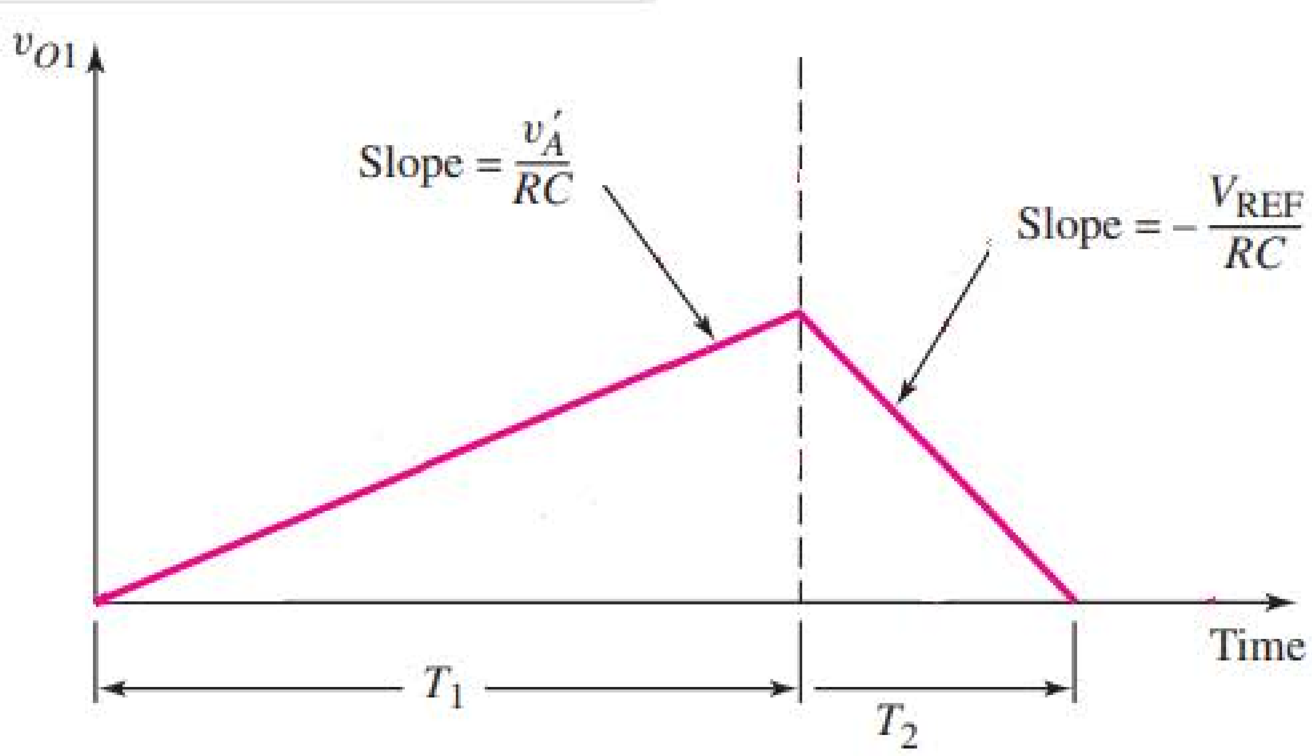
Not in syllabus

Sorry, couldn't parse formula

How much time it would take to produce the output from the moment switch S_2 is connected to $-v'_A$?

Not in syllabus μs

Sorry, couldn't parse formula



Find the value of v_{O1} at $t = T_1$, suppose $R = 10k\Omega$ and $C = 5\mu F$.

Not in syllabus V

Sorry, couldn't parse formula

Homework 7

7.1.1

$$QE = \frac{\Delta Q}{V_{max} - V_{min}}$$

$$\Delta Q = \frac{1}{2} \times \frac{V_{max} - V_{min}}{2^n} \quad [n = \text{number of bits}]$$

So,

$$QE = \frac{1}{2} \times \frac{V_{max} - V_{min}}{2^n} \times \frac{1}{V_{max} - V_{min}}$$

$$\Rightarrow QE = \frac{1}{2^{n+1}}$$

$$\Rightarrow 0.098 \times \frac{1}{100} = \frac{1}{2^{n+1}}$$

$$\Rightarrow 2^{n+1} = \frac{100}{0.098} \Rightarrow n+1 = \log_2\left(\frac{100}{0.098}\right)$$

$$\boxed{n = 9}$$

7.1.2

$S_1 \quad S_2 \quad S_3 \quad S_4$

MSB $\longleftarrow$ LSB

$$V_o = \left(-\frac{R_F}{R_4} \times V_{S_4}\right) + \left(-\frac{R_F}{R_3} \times V_{S_3}\right) + \left(-\frac{R_F}{R_2} \times V_{S_2}\right) + \left(-\frac{R_F}{R_1} \times V_{S_1}\right)$$

So, for input 0101.

$$V_o = \left(-\frac{10}{160} \times -5\right) + \left(-\frac{10}{80} \times 0\right) + \left(-\frac{10}{40} \times -5\right) + \left(-\frac{10}{20} \times 0\right)$$

$$\boxed{V_o = 1.5625 \text{ V}}$$

$$1\ LSB = \left(-\frac{R_f}{R_4} \times V_{S4}\right) = \left(-\frac{10}{160} \times -5\right)$$

$$= 0.3125V$$

$$\therefore \frac{1}{2} LSB = \frac{0.3125}{2} = 0.15625V$$

$$\therefore 1\ MSB = \left(\frac{-R_f}{R_1} \times V_{S1}\right) = \left(-\frac{10}{20} \times -5\right)$$

$$= 2.5V$$

S_1 is ON $\rightarrow$ $2.5 \pm 0.15625V$

$$\therefore \left(-\frac{10}{R_1} \times -5\right) = (2.5 + 0.15625)$$

$$\Rightarrow R_1 = 18.8235\,k\Omega$$

$$\therefore \text{max error} = \frac{20 - 18.8235}{20} \times 100$$

$$\boxed{= 5.8823\%}$$

7.2.1

$$I = \frac{V_{ref}}{R_{total}}$$

$$\Rightarrow I = \frac{11}{\frac{3R}{2} + 6R + \frac{R}{2}} = \frac{11}{8R}$$

$$\therefore V_1 = I \times \frac{R}{2} = \frac{11}{8R} \times \frac{R}{2} = 0.6875V$$

$$\therefore V_2 = I \times \left(\frac{R}{2} + R\right) = \frac{11}{8R} \times \frac{3R}{2} = 2.0625V$$

$$\therefore V_3 = I \times \left(\frac{R}{2} + 2R\right) = \frac{11}{8R} \times \frac{5R}{2} = 3.4375V$$

$$\therefore V_4 = I \times \left(\frac{R}{2} + 3R\right) = \frac{11}{8R} \times \frac{7R}{2} = 4.8125V$$

$$\therefore V_5 = I \times \left(\frac{R}{2} + 4R\right) = \frac{11}{8R} \times \frac{9R}{2} = 6.1875V$$

$$\therefore V_6 = I \times \left(\frac{R}{2} + 5R\right) = \frac{11}{8R} \times \frac{11R}{2} = 7.5625V$$

$$\therefore V_7 = I \times \left(\frac{R}{2} + 6R\right) = \frac{11}{8R} \times \frac{13R}{2} = 8.9375V$$

V_7	V_6	V_5	V_4	V_3	V_2	V_1	output
OFF	OFF	OFF	OFF	OFF	OFF	OFF	000
OFF	OFF	OFF	OFF	OFF	OFF	ON	001
OFF	OFF	OFF	OFF	OFF	ON	ON	010
OFF	OFF	OFF	OFF	ON	ON	ON	011
OFF	OFF	OFF	ON	ON	ON	ON	100
OFF	OFF	ON	ON	ON	ON	ON	101
OFF	ON	ON	ON	ON	ON	ON	110
ON	ON	ON	ON	ON	ON	ON	111

So, For output 110,

Upto V_6 ON,

$\therefore$ min value of $V_A = V_6 = \boxed{7.5625\,V}$

max value of $V_A = V_7 = \boxed{8.9375\,V}$

7.2.2

Resistor required $= 2^n = 2^6 = \boxed{64}$

Comparators need $= 2^n - 1 = 2^6 - 1 = \boxed{63}$

7.3.1

for 8bit,

$$V_0 = (-V_{ref})\left(b_1 + \frac{b_2}{2} + \frac{b_3}{4} + \frac{b_4}{8} + \frac{b_5}{16} + \frac{b_6}{32} + \frac{b_7}{64} + \frac{b_8}{128}\right)$$

for output $\overset{b_1}{0}100101\overset{b_8}{0}$,

$$V_0' = (-(-8))\left(0 + \frac{1}{2} + \frac{0}{4} + \frac{0}{8} + \frac{1}{16} + \frac{0}{32} + \frac{1}{64} + \frac{0}{128}\right)$$

$$= 8 \times \frac{37}{84} = 4.625V$$

for output $\overset{b_1 \searrow}{0}0010000 \overset{\swarrow b_8}{,}$

$$V_o'' = (-(-8))\left(0 + \frac{0}{2} + \frac{0}{4} + \frac{1}{8} + \frac{0}{16} + \frac{0}{32} + \frac{0}{64} + \frac{0}{128}\right)$$

$$= 8 \times \frac{1}{8} = 1V$$

$\therefore$ changes, $V_o'' - V_o' = 1 - 4.625$

$$\boxed{= -3.625V}$$

7.3.2

$$T = \frac{1}{f} = \frac{1}{2MHz} = 0.5\mu s$$

clock cycle needed = no. of bit + 1

$= 8 + 1 = 9$

$\therefore$ conversion time $= 0.5 \times 9\ \mu s$

$$\boxed{= 4.5\mu s}$$

7.4.1

$\boxed{\text{NOT IN Syllabus}}$