Name: Key
Section: =

EE331 Homework PS4 – fall 2012

Problems from Alexander & Sadiku:

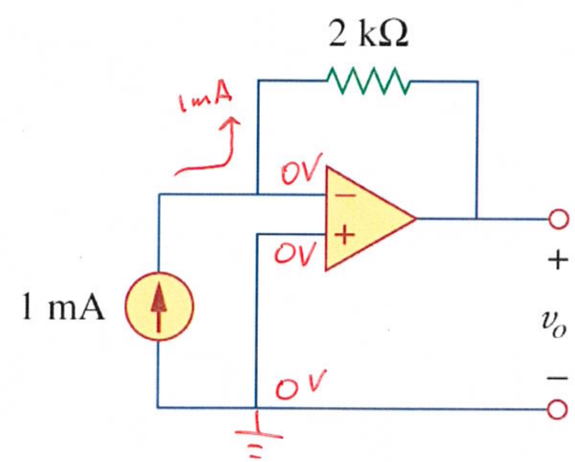
CH5

- 5.8 – Warm up! *Ans*: a) -2V, b) -1V
- 5.13 (Remember your ideal Op Amp assumptions, equations 5.5 and 5.7) – A voltage divider works quite nicely to get this problem rolling.
- 5.21
- 5.27
- 5.37
- 5.47

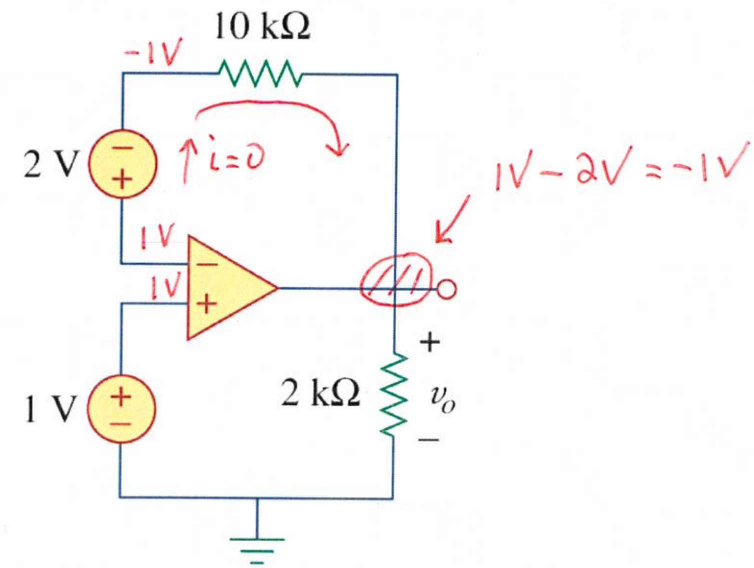
Additional Problems (Instructor Option):

- Read page 196-197 in your text and solve Practice Problem 5.12 (on page 197)
- Any as assigned by instructor

Figure 5.47



(a)



(b)

- Use (5.5) and (5.7)

a) $V_o = 0 - 1mA \cdot 2k\Omega$
$= \boxed{-2V}$

(No current through 10 kΩ)

b) $V_o = 1V - 2V = \boxed{-1V}$

Chapter 5, Problem 13

Find v_o and i_o in the circuit of Fig. 5.52.

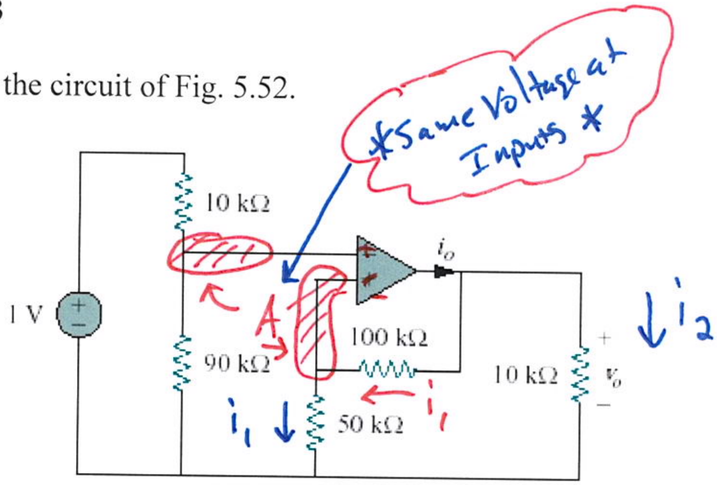


Figure 5.52 for Prob. 5.13

- Use Voltage Divider to find V_A

$$V_A = \frac{1V \cdot 90k\Omega}{(90k\Omega + 10k\Omega)} = 0.9V$$

- Now find i_1

$$i_1 = \frac{V_A}{50k\Omega} = 18\mu A$$

- $V_o = V_A + i_1 \cdot 100k\Omega = 2.7V$

(KCL) • $i_o = i_1 + i_2 = 18\mu A + \frac{2.7V}{10k\Omega} = 18\mu A + 0.27mA = 288\mu A$

Chapter 5, Problem 21.

Calculate v_o in the op amp circuit of Fig. 5.60.

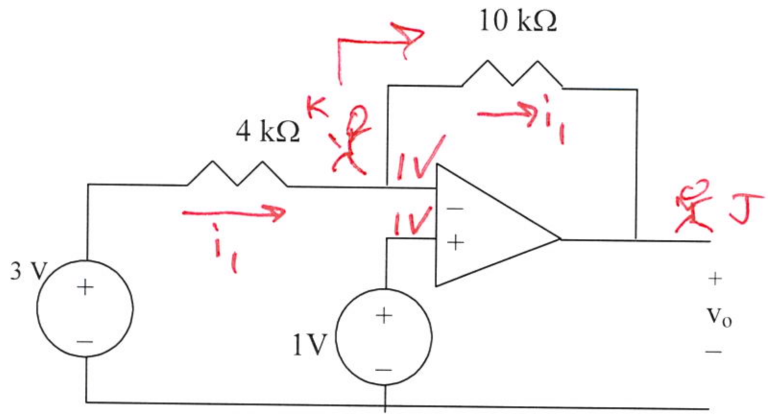


Figure 5.60 **For Prob. 5.21.**

$$i_1 = \frac{3V - 1V}{4K\Omega} = 0.5\,mA$$

$$V_o = 1V - \underbrace{\overset{i_1}{0.5mA} \cdot 10K\Omega}_{I \cdot R} = -4V$$

Chapter 5, Problem 27.

Find v_o in the op amp circuit in Fig. 5.65.

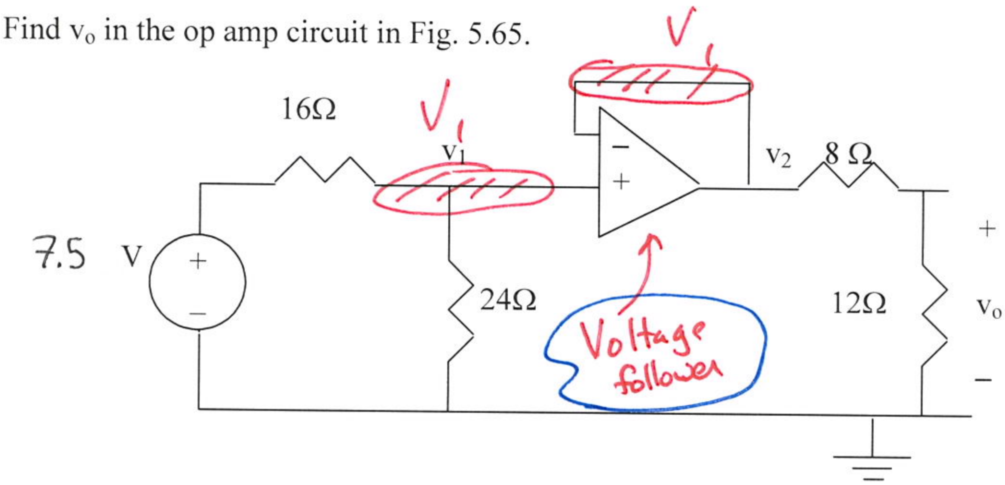


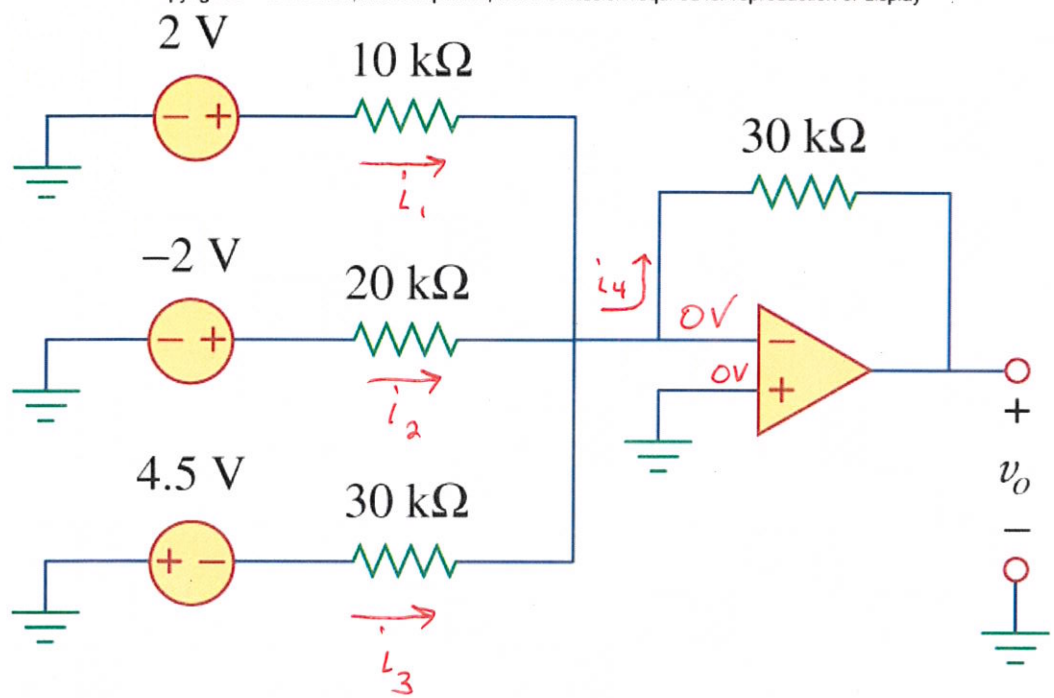
Figure 5.65 **For Prob. 5.27.**

- $V_1 = 7.5V \cdot \frac{24\Omega}{(16\Omega + 24\Omega)} = 4.5V$

$V_2 = V_1 = 4.5V$

$$V_o = \frac{4.5V \cdot 12\Omega}{(8\Omega + 12\Omega)} = 2.7V$$

Figure 5.74



- $i_1 = 2V / 10k\Omega = 0.2mA$
- $i_2 = -2V / 20k\Omega = -0.1mA$
- $i_3 = -4.5V / 30k\Omega = -0.15mA$

$\Rightarrow i_4 = -0.05mA$

$\Rightarrow V_o = 0 + 0.05mA \cdot 30k\Omega = \boxed{1.5V}$

Chapter 5, Problem 47.

The circuit in Fig. 5.79 is for a difference amplifier. Find v_o given that v_1 =1V and v_2 = 2V.

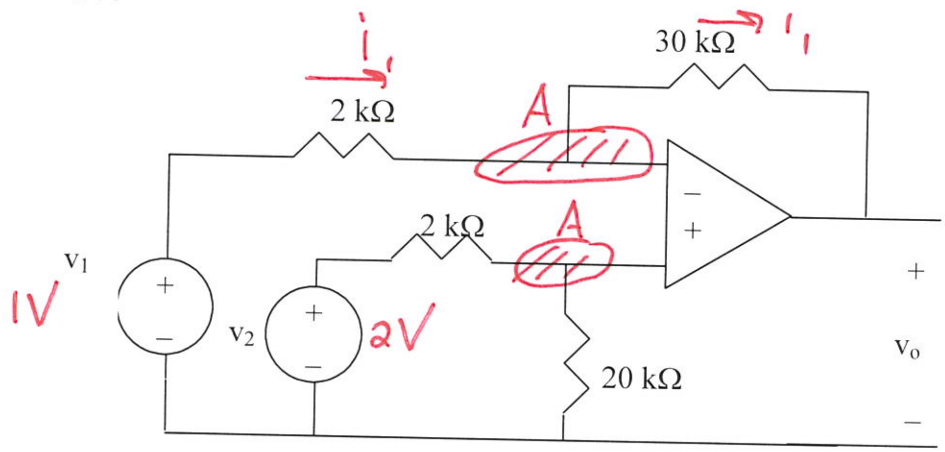


Figure 5.79 **For Prob. 5.47.**

- $V_A = \dfrac{2V \cdot 20k\Omega}{(2k\Omega + 20k\Omega)} = 1.82V$
- $i_1 = \dfrac{1V - 1.82V}{2k\Omega} = -410\mu A$
- $V_o = 1.82V + 410\mu A \cdot 30k\Omega = \boxed{14.1V}$

(b/c "−" current)

Digital to ANALog Converter (Binary Weighted LADDER)

A three-bit DAC is shown in Fig. 5.37.

Practice Problem 5.12

(a) Determine $|V_o|$ for $[V_1V_2V_3] = [010]$.
(b) Find $|V_o|$ if $[V_1V_2V_3] = [110]$.
(c) If $|V_o| = 1.25$ V is desired, what should be $[V_1V_2V_3]$?
(d) To get $|V_o| = 1.75$ V, what should be $[V_1V_2V_3]$?

Answer: 0.5 V, 1.5 V, [101], [111].

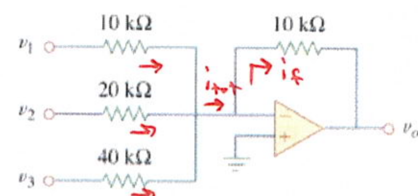


Figure 5.37
Three-bit DAC; for Practice Prob. 5.12.

$i_{tot} = i_f$

$$(5.23)\quad -V_o = \frac{R_f}{R_1}V_1 + \frac{R_f}{R_2}V_2 + \frac{R_f}{R_3}V_3 = R_f\left(\frac{V_1-0}{R_1} + \frac{V_2-0}{R_2} + \frac{V_3-0}{R_3}\right)$$

(R_1 = 10kΩ, R_2 = 20kΩ, R_3 = 40kΩ)

a) $|V_o| = 0 + \frac{10k\Omega}{20k\Omega}\cdot 1V + 0 = 0.5V$

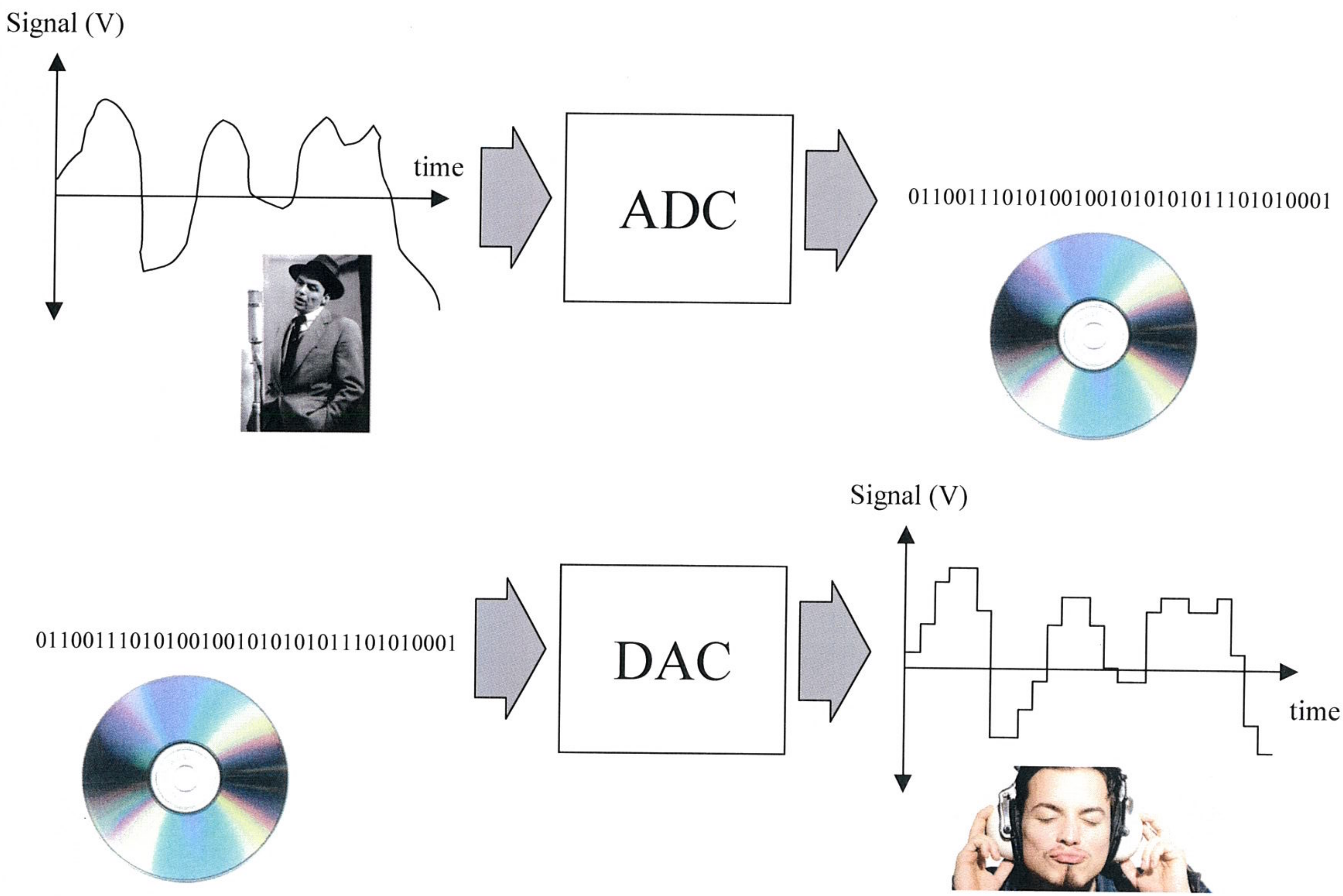
b) $|V_o| = \frac{10k\Omega}{10k\Omega}\cdot 1 + \frac{10k\Omega}{20k\Omega}\cdot 1V + 0 = 1.5V$

c) $101 \rightarrow |V_o| = \frac{10k}{10k}\cdot 1 + 0 + \frac{10k}{40k}\cdot 1 = 1.25V$

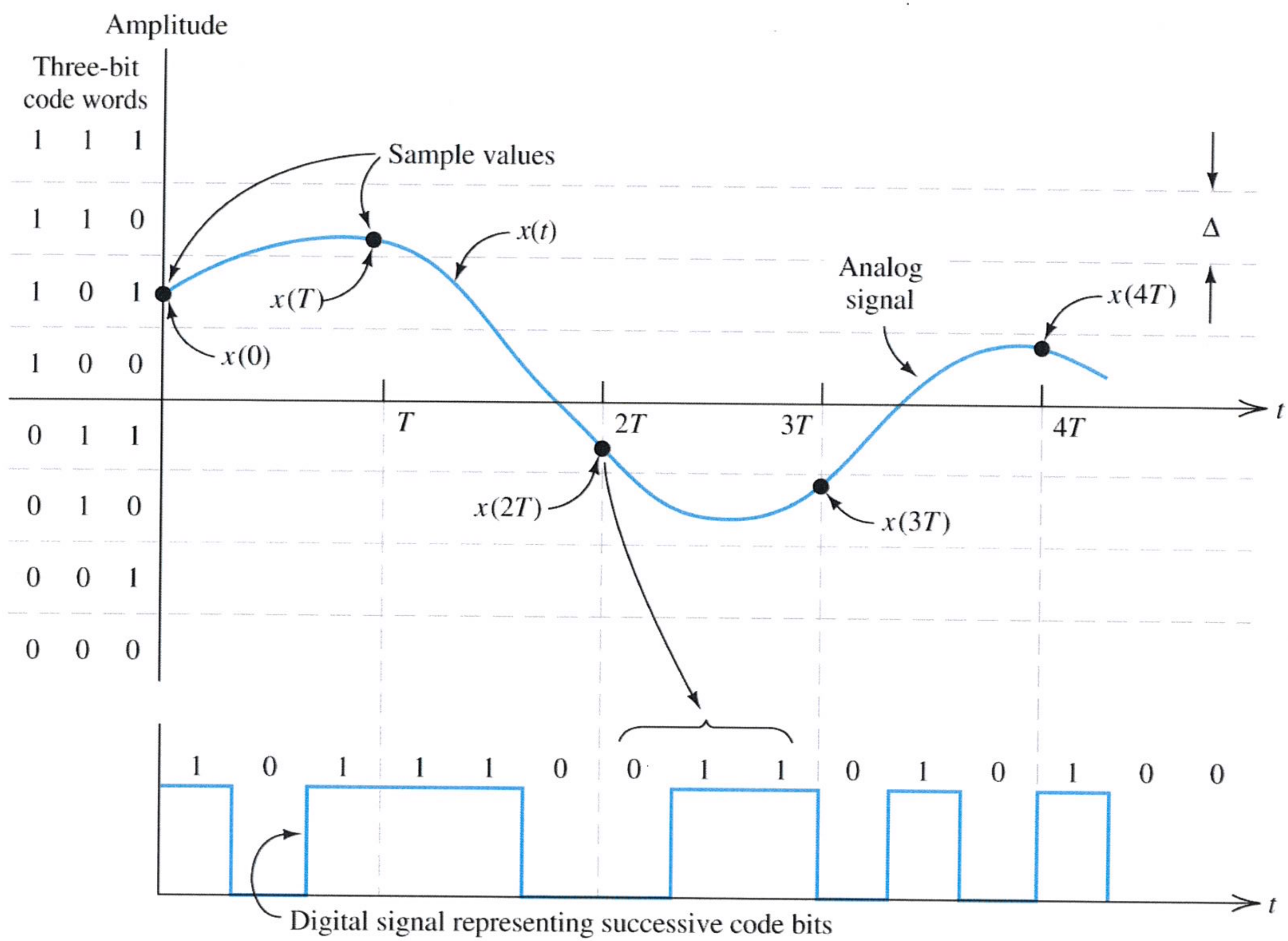
d) $111 \rightarrow |V_o| = \frac{10k}{10k}\cdot 1 + \frac{10k}{20k}\cdot 1 + \frac{10k}{40k}\cdot 1 = 1.75V$

Note	OUTPUT ($\lvert V_o \rvert$) V
000	0
001	0.25
010	0.5
011	0.75
100	1.00
101	1.25
110	1.5
111	1.75

(*) Summary/High Level Look at Analog-to-Digital and Digital-to-Analog (NEXT 3 Slides)


Signal (V)
time
ADC
01100111010100100101010101110101000
Signal (V)
01100111010100100101010101110101000
DAC
time

Analog to Digital (ADC) Hambley pg. 316



Digital to Analog (DAC) Hambley pg. 316