Ingeniería Informática

Medios de Transmisión (MT)

Tema 5

Representación digital de señales continuas

Curso 2007-08

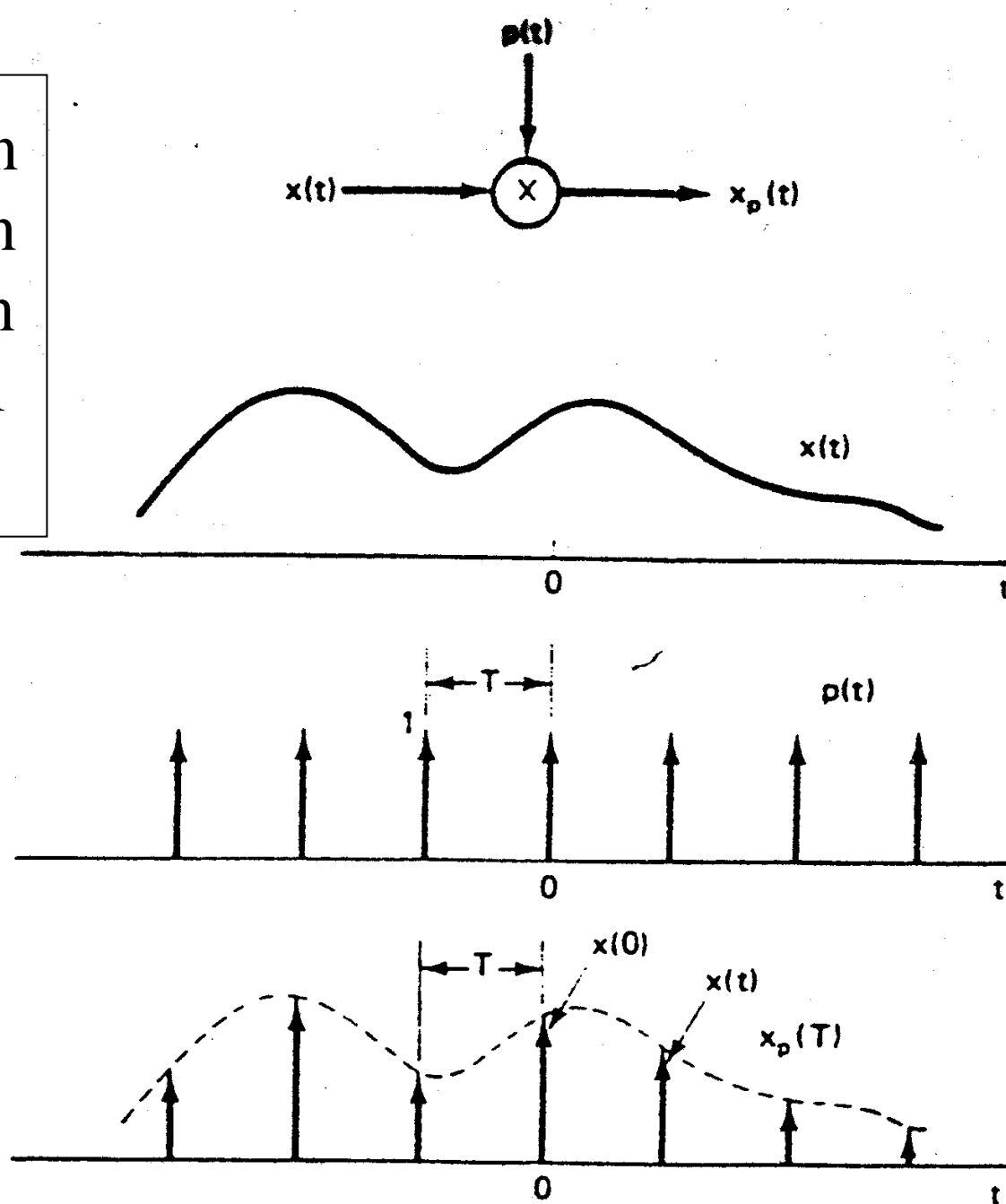Representación de la operación de muestreo en el dominio del tiempo

Figure 8.3 Pulse amplitude modulation with an impulse train.

Ilustración del carácter no invertible de la operación de muestreo
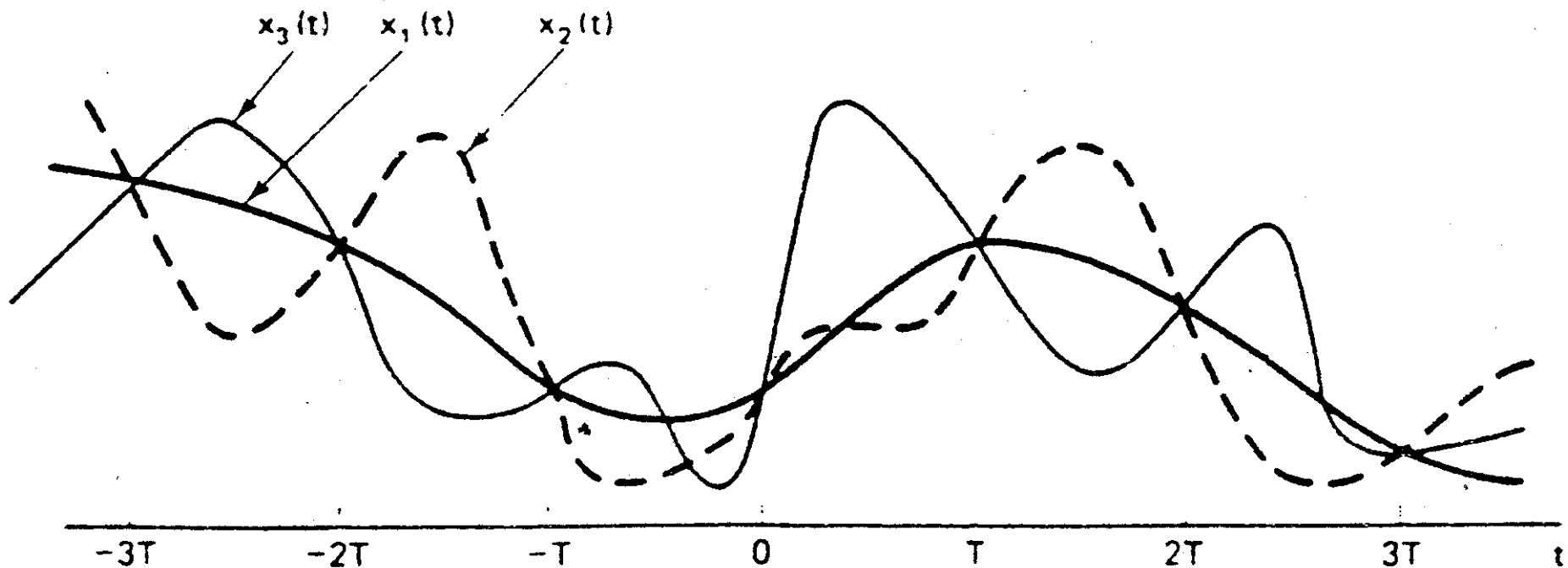
$$x_1(kT) = x_2(kT) = x_3(kT)$$

Figure 8.1 Three continuous-time signals with identical values at integer multiples of T.
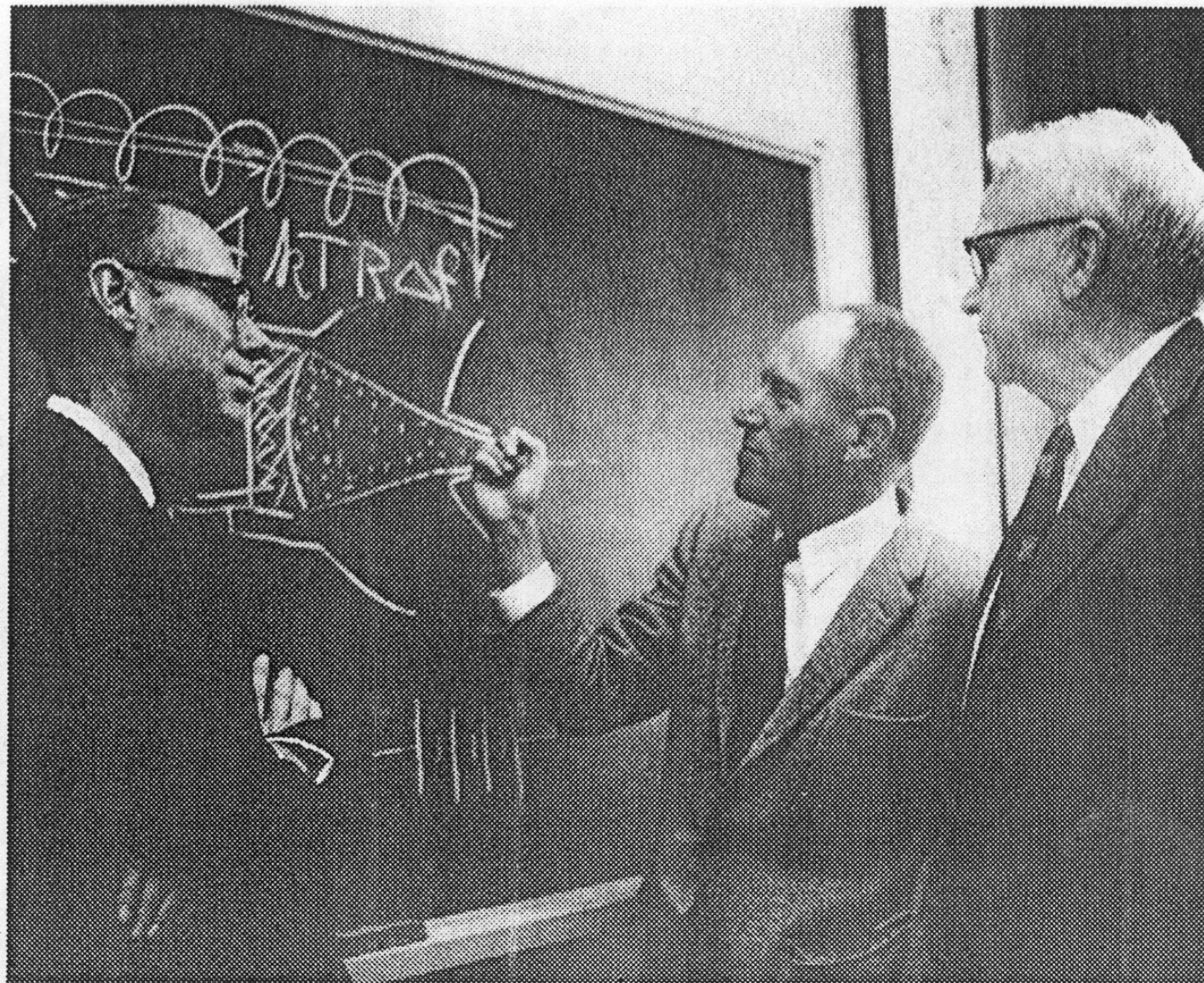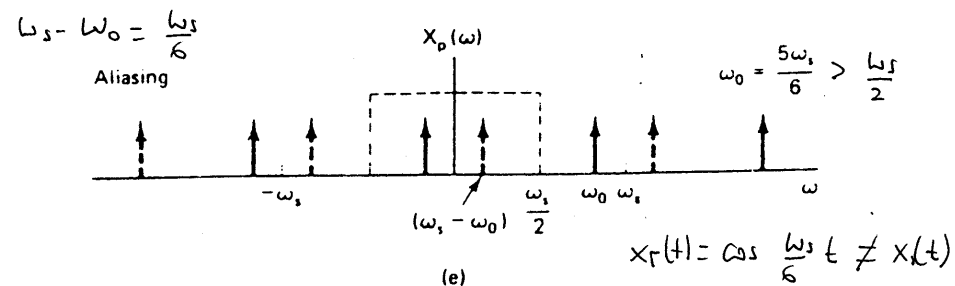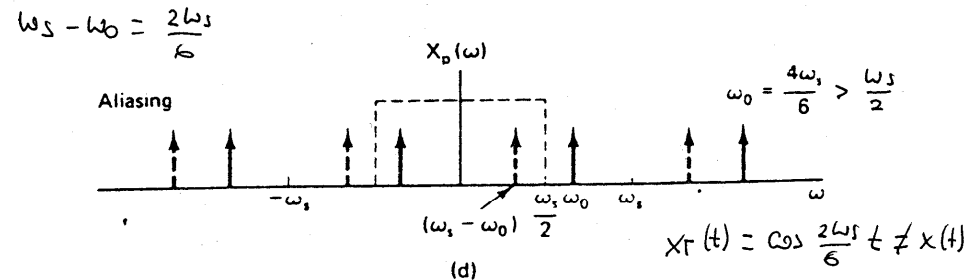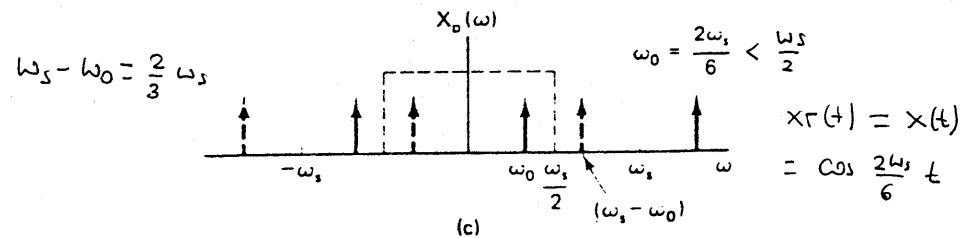
Fig. 12. John R. Pierce (left) in a discussion at the chalkboard with Rudolf Kompfner (center) and Harry Nyquist on the theory of the traveling-wave tube. (Property of AT&T Archives. Reprinted with permission of AT&T.)

Ilustración del fenómeno de solapamiento en el dominio de la frecuencia

$X(\omega)$

$x(t) = \cos \omega_0 t$

π π

$-\omega_0$ ω_0 ω

(a)

$X_p(\omega)$

$\omega_s - \omega_0 = \dfrac{5\omega_s}{6}$

$\omega_0 = \dfrac{\omega_s}{6} < \dfrac{\omega_s}{2}$

$-\omega_s$ ω_0 $\dfrac{\omega_s}{2}$ ω_s ω

$(\omega_s - \omega_0)$

$x_r(t) = x(t)$

$= \cos \dfrac{\omega_s}{6} t$

(b)

$X_p(\omega)$

$\omega_s - \omega_0 = \dfrac{2}{3}\omega_s$

$\omega_0 = \dfrac{2\omega_s}{6} < \dfrac{\omega_s}{2}$

$-\omega_s$ ω_0 $\dfrac{\omega_s}{2}$ ω_s ω

$(\omega_s - \omega_0)$

$x_r(t) = x(t)$

$= \cos \dfrac{2\omega_s}{6} t$

(c)

$\omega_s - \omega_0 = \dfrac{2\omega_s}{6}$

$X_p(\omega)$

Aliasing

$\omega_0 = \dfrac{4\omega_s}{6} > \dfrac{\omega_s}{2}$
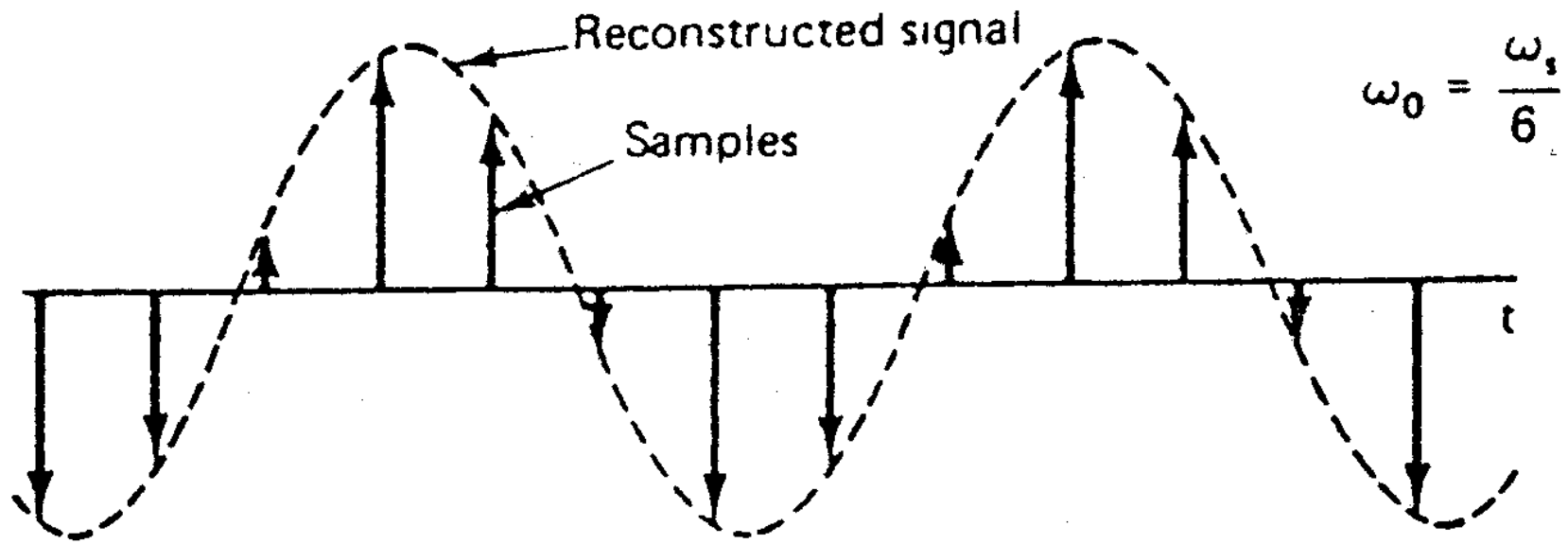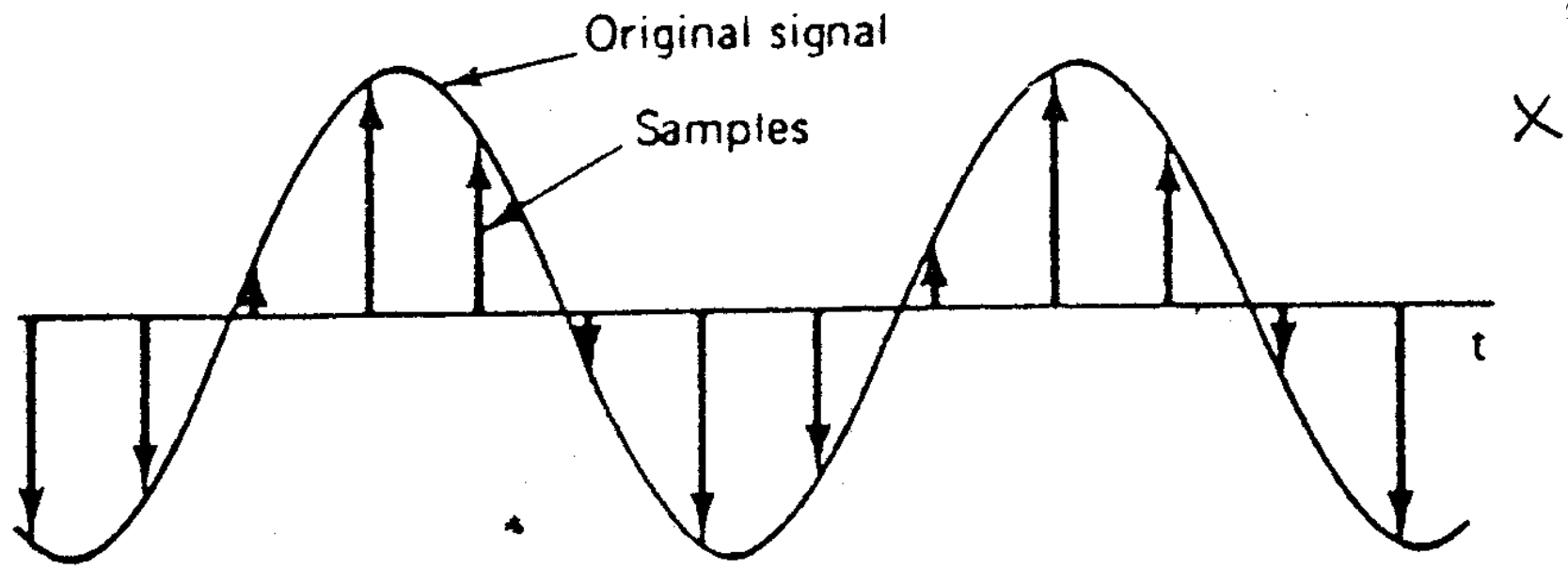
$-\omega_s$ $(\omega_s - \omega_0)$ $\dfrac{\omega_s}{2}$ ω_0 ω_s ω

$x_r(t) = \cos \dfrac{2\omega_s}{6} t \neq x(t)$

(d)

$\omega_s - \omega_0 = \dfrac{\omega_s}{6}$

$X_p(\omega)$

Aliasing

$\omega_0 = \dfrac{5\omega_s}{6} > \dfrac{\omega_s}{2}$

$-\omega_s$ $(\omega_s - \omega_0)$ $\dfrac{\omega_s}{2}$ ω_0 ω_s ω

$x_r(t) = \cos \dfrac{\omega_s}{6} t \neq x(t)$

(e)

Original signal

Samples

X

t

Reconstructed signal

$\omega_0 = \dfrac{\omega_s}{6}$

Samples

t

(a)

$$\omega_0 = \frac{2\omega_s}{6}$$

(b)
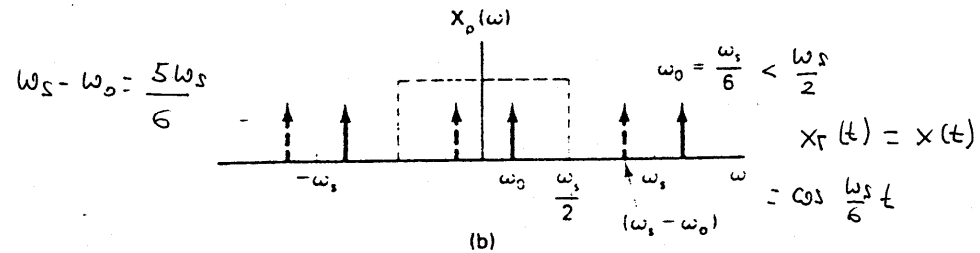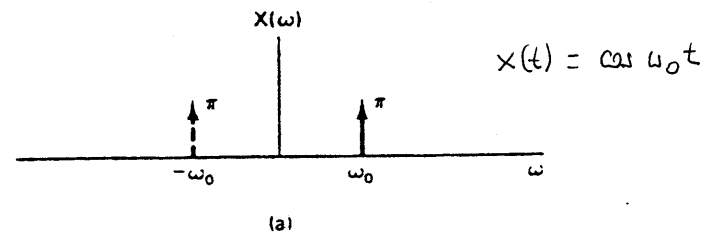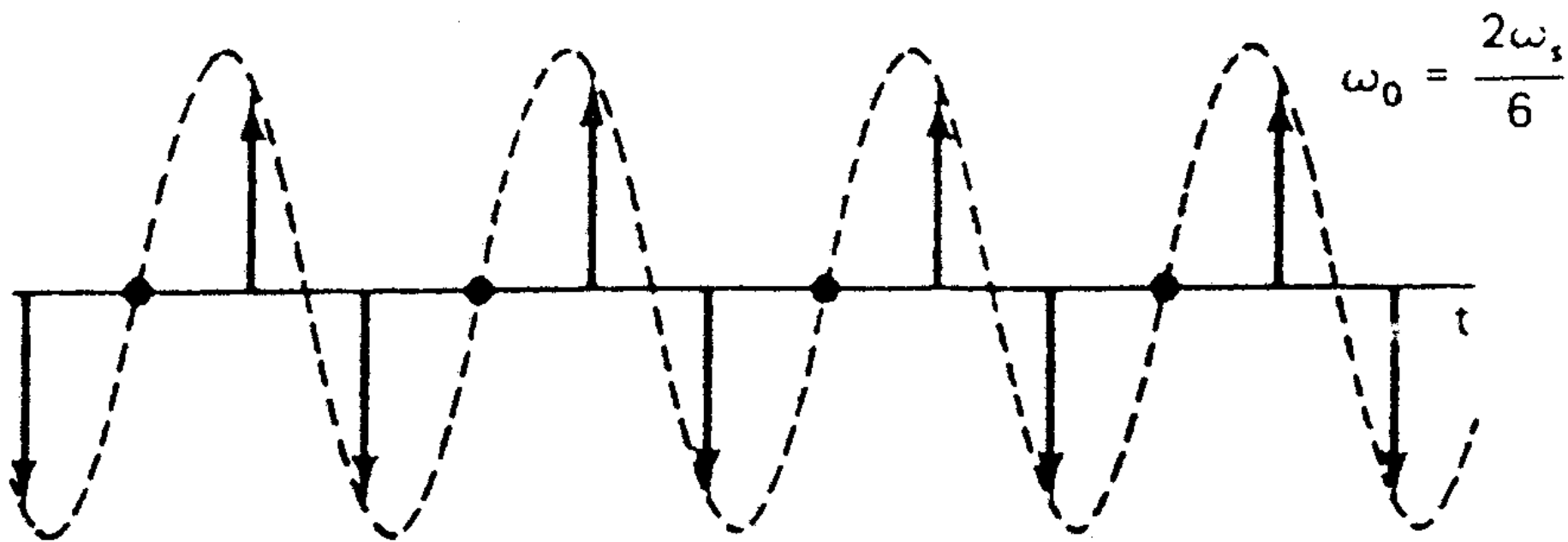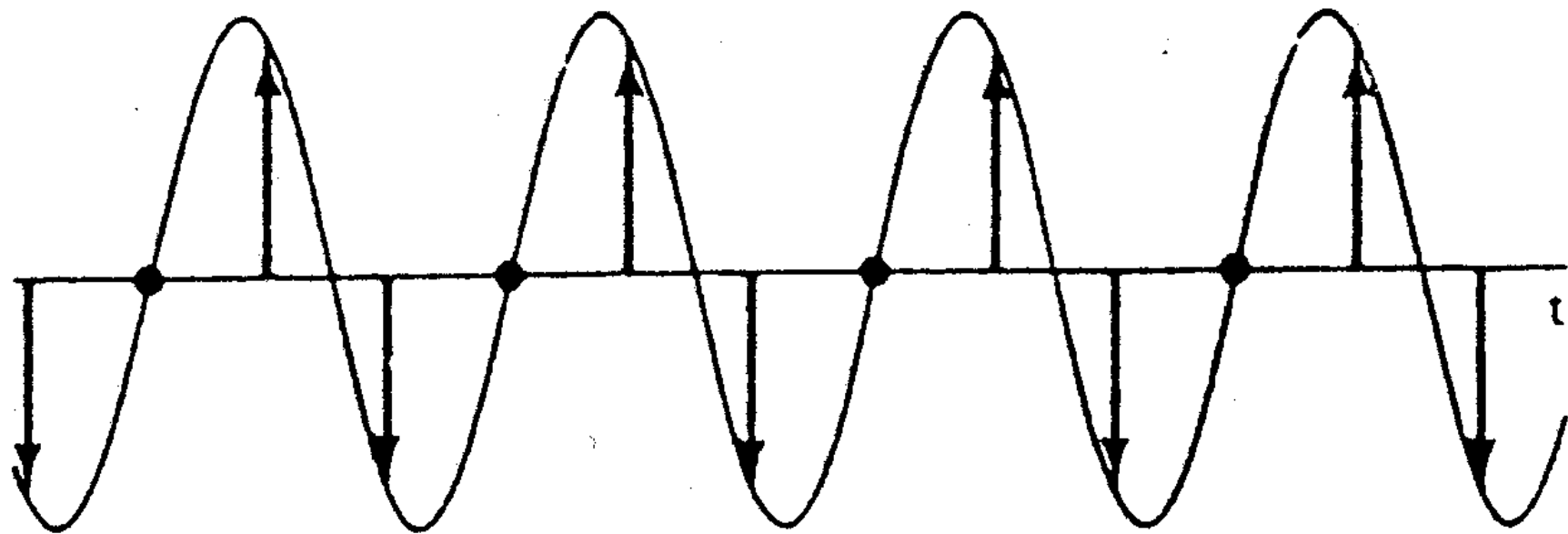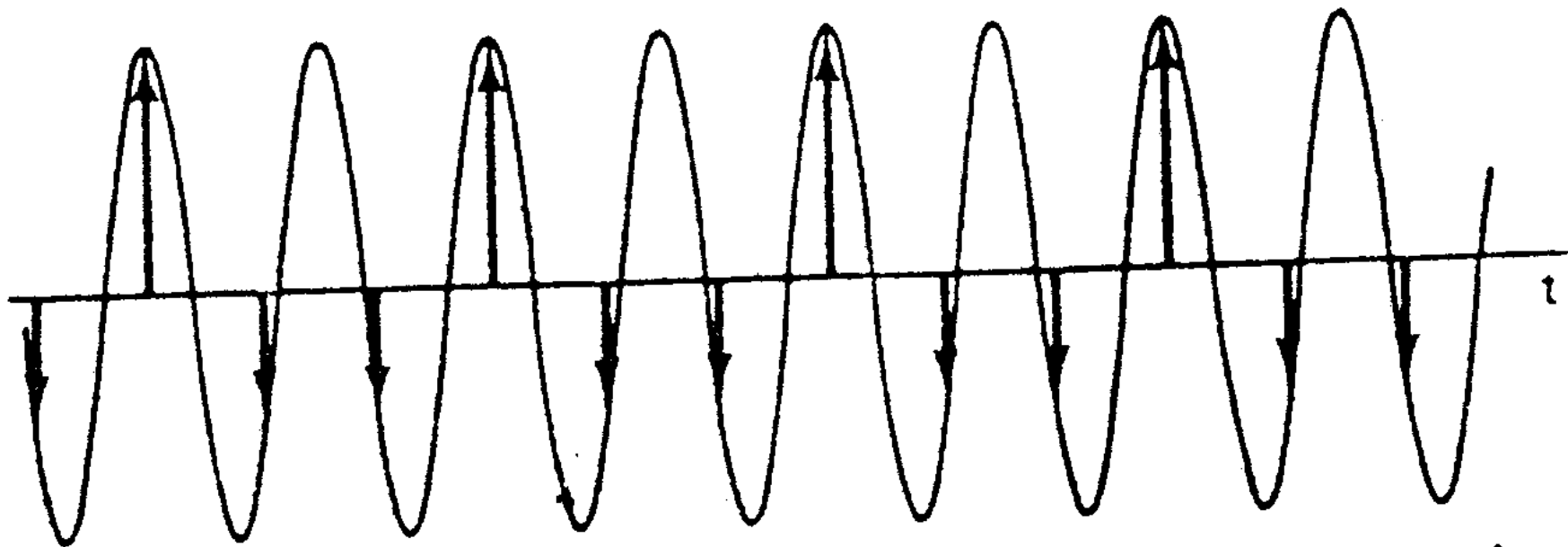
$$\omega_0 = \frac{4\omega_s}{6}$$

$$\omega_0 = \frac{5\omega_s}{6}$$

(d)

Ejemplo de cuantificación de una señal muestreada

Codificación de textos: código ASCII

Bits			5	0	1	0	1	0	1	0	1
			6	0	0	1	1	0	0	1	1
1	2	3	4	7	0	0	0	0	1	1	1	1

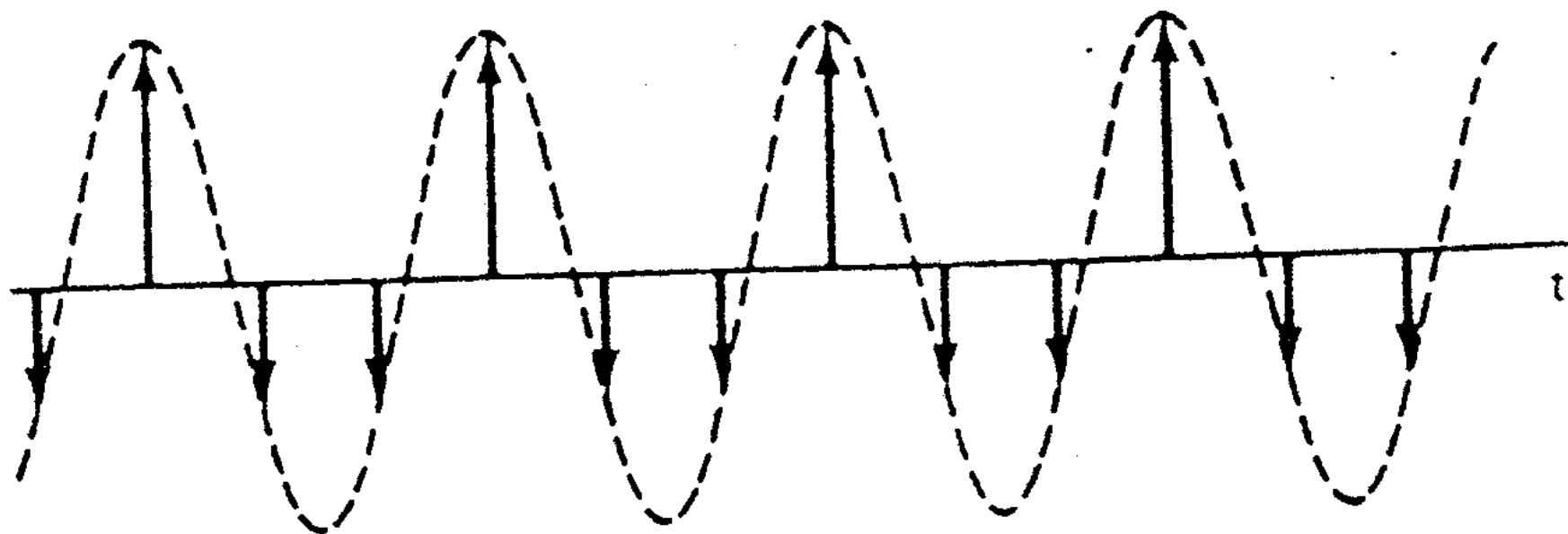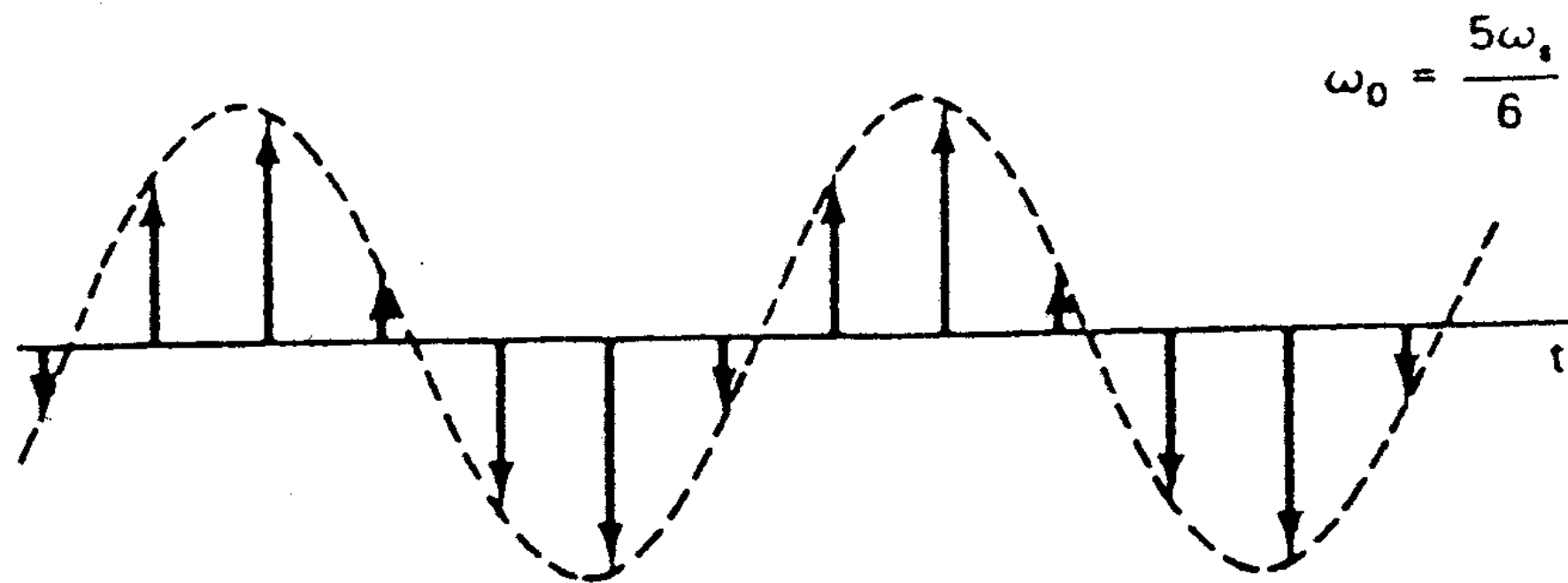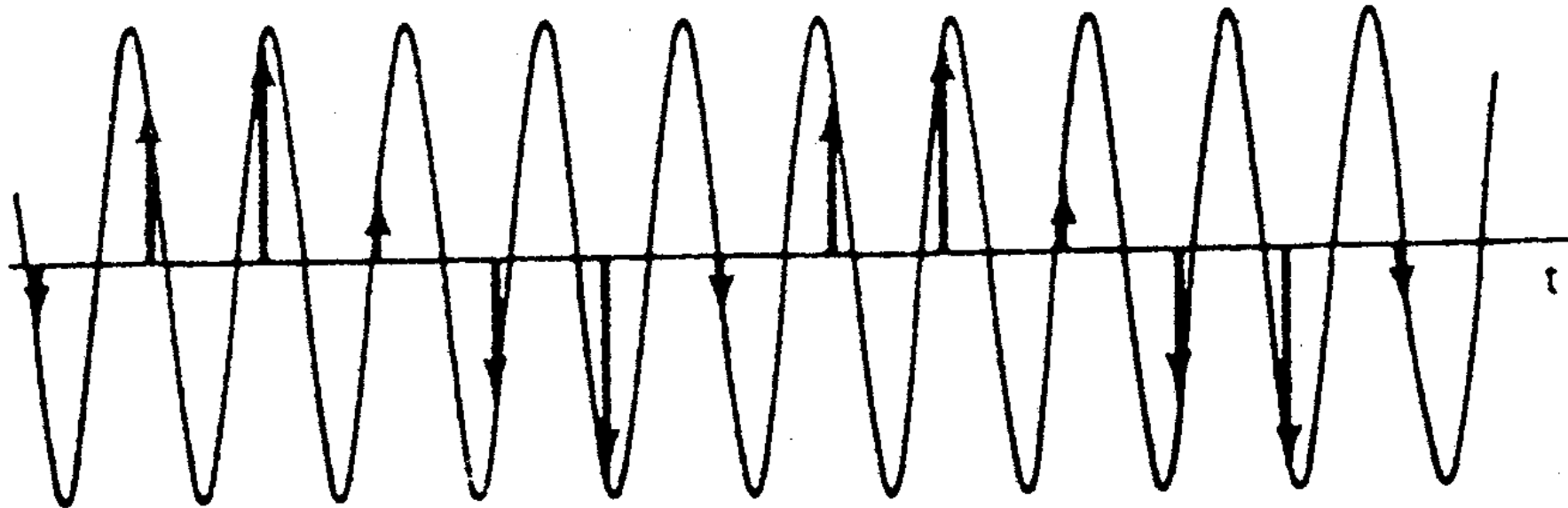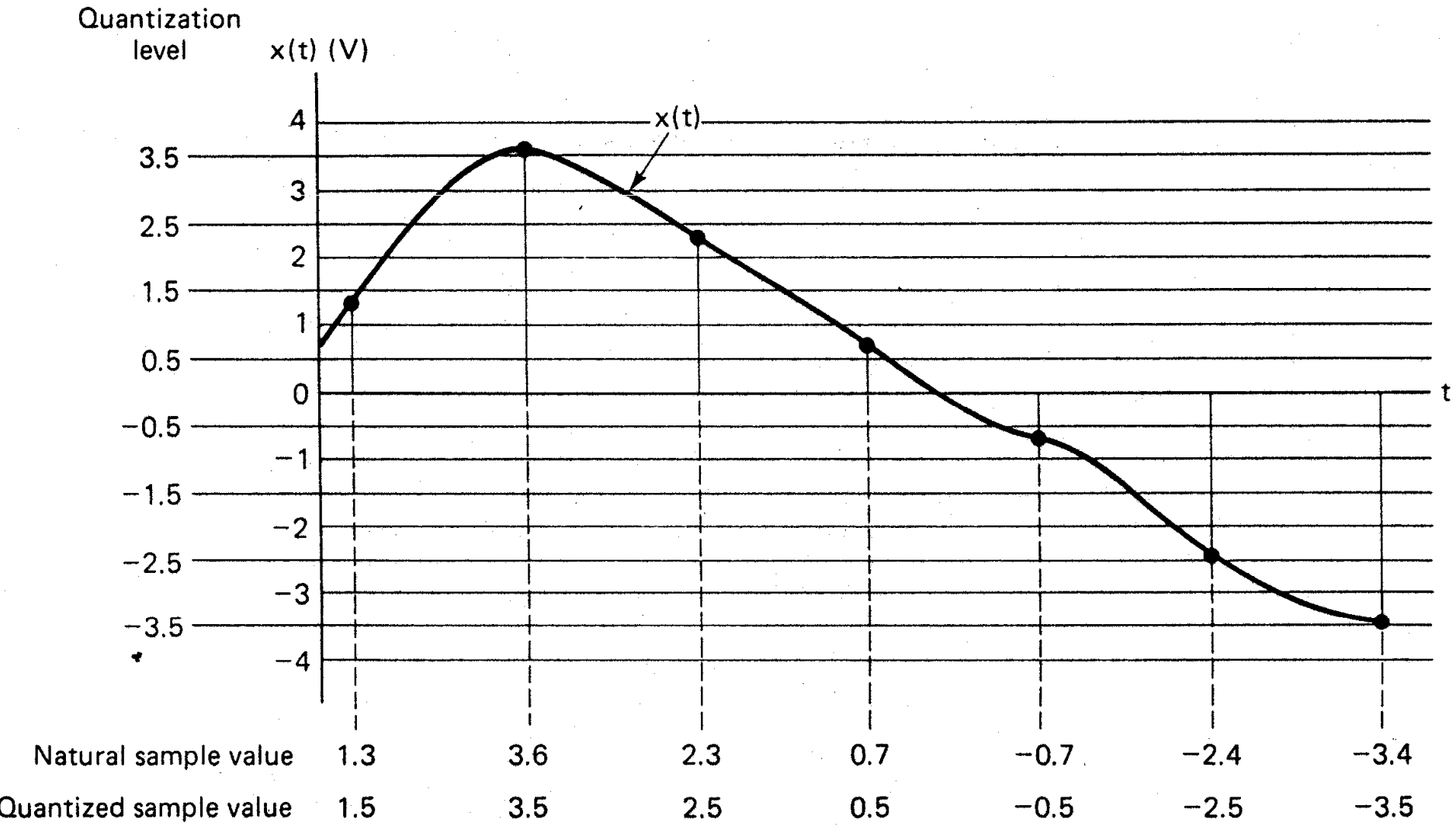| 1	2	3	4								
0	0	0	0	NUL	DLE	SP	0	@	P	`	p
1	0	0	0	SOH	DC1	!	1	A	Q	a	q
0	1	0	0	STX	DC2	"	2	B	R	b	r
1	1	0	0	ETX	DC3	#	3	C	S	c	s
0	0	1	0	EOT	DC4	$	4	D	T	d	t
1	0	1	0	ENQ	NAK	%	5	E	U	e	u
0	1	1	0	ACK	SYN	&	6	F	V	f	v
1	1	1	0	BEL	ETB	'	7	G	W	g	w
0	0	0	1	BS	CAN	(	8	H	X	h	x
1	0	0	1	HT	EM	)	9	I	Y	i	y
0	1	0	1	LF	SUB	*	:	J	Z	j	z
1	1	0	1	VT	ESC	+	;	K	[	k	{
0	0	1	1	FF	FS	,	<	L	\	l	|
1	0	1	1	CR	GS	–	=	M	]	m	}
0	1	1	1	SO	RS	.	>	N	^	n	~
1	1	1	1	SI	US	/	?	O	–	o	DEL

NUL	Null, or all zeros	DC1	Device control 1
SOH	Start of heading	DC2	Device control 2
STX	Start of text	DC3	Device control 3
ETX	End of text	DC4	Device control 4
EOT	End of transmission	NAK	Negative acknowledge
ENQ	Enquiry	SYN	Synchronous idle
ACK	Acknowledge	ETB	End of transmission block
BEL	Bell, or alarm	CAN	Cancel
BS	Backspace	EM	End of medium
HT	Horizontal tabulation	SUB	Substitute
LF	Line feed	ESC	Escape
VT	Vertical tabulation	FS	File separator
FF	Form feed	GS	Group separator
CR	Carriage return	RS	Record separator
SO	Shift out	US	Unit separator
SI	Shift in	SP	Space
DLE	Data link escape	DEL	Delete

Figure 2.3   Seven-bit American standard code for information interchange (ASCII).

Codificación de señales continuas: PCM (Pulse Code Modulation)

Natural sample value	1.3	3.6	2.3	0.7	−0.7	−2.4	−3.4
Quantized sample value	1.5	3.5	2.5	0.5	−0.5	−2.5	−3.5
Code number	5	7	6	4	3	1	0
PCM sequence	101	111	110	100	011	001	000
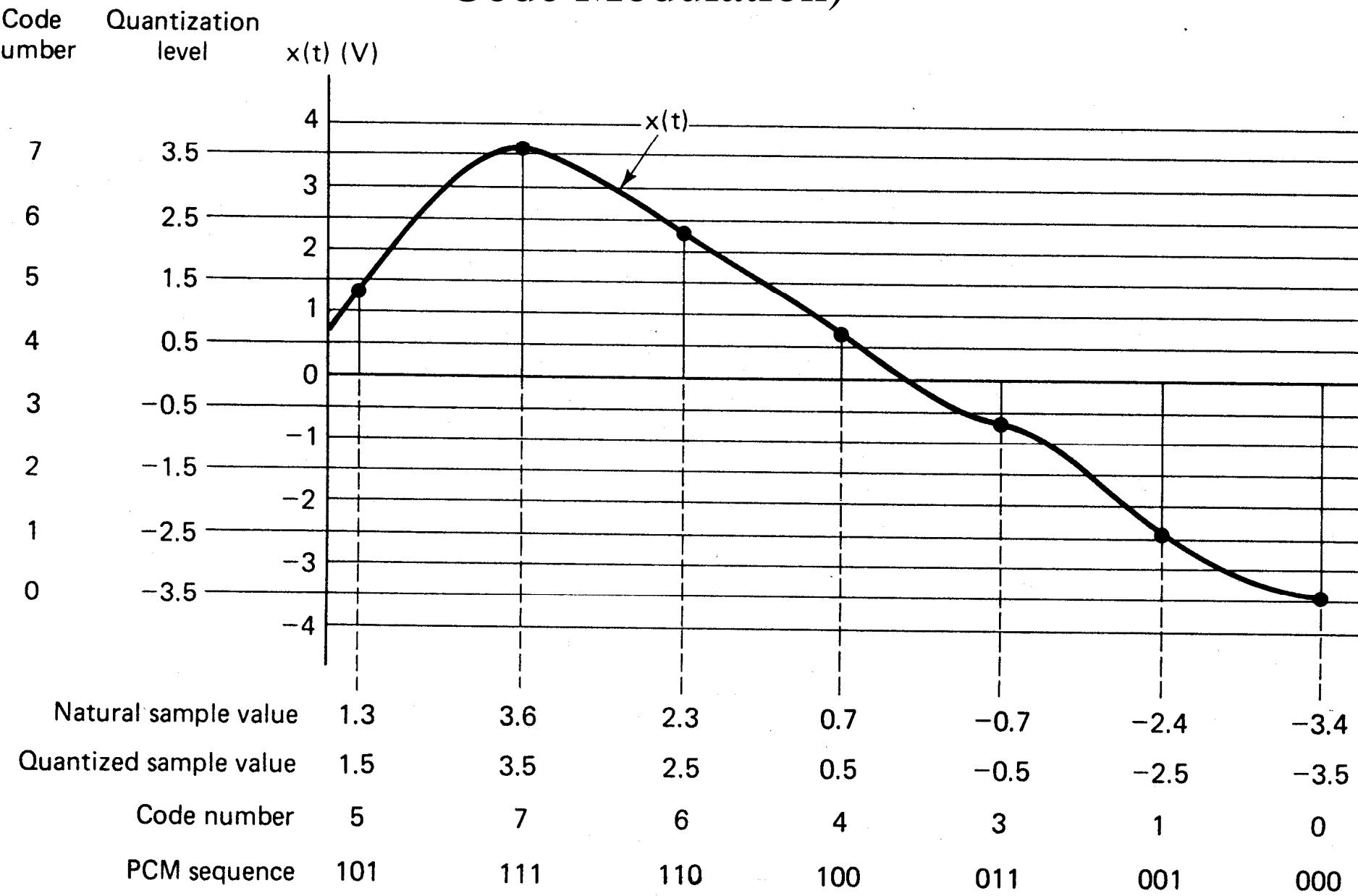
Table 2.1 Frequency of Occurrences in English Text (From Reza [17])

Symbol	Probability	Symbol	Probability
space	0.1859	N	0.0574
A	0.0642	O	0.0632
B	0.0127	P	0.0152
C	0.0218	Q	0.0008
D	0.0317	R	0.0484
E	0.1031	S	0.0514
F	0.0208	T	0.0796
G	0.0152	U	0.0228
H	0.0467	V	0.0083
I	0.0575	W	0.0175
J	0.0008	X	0.0013
K	0.0049	Y	0.0164
L	0.0321	Z	0.0005
M	0.0198		

Samuel Morse
1791-1872
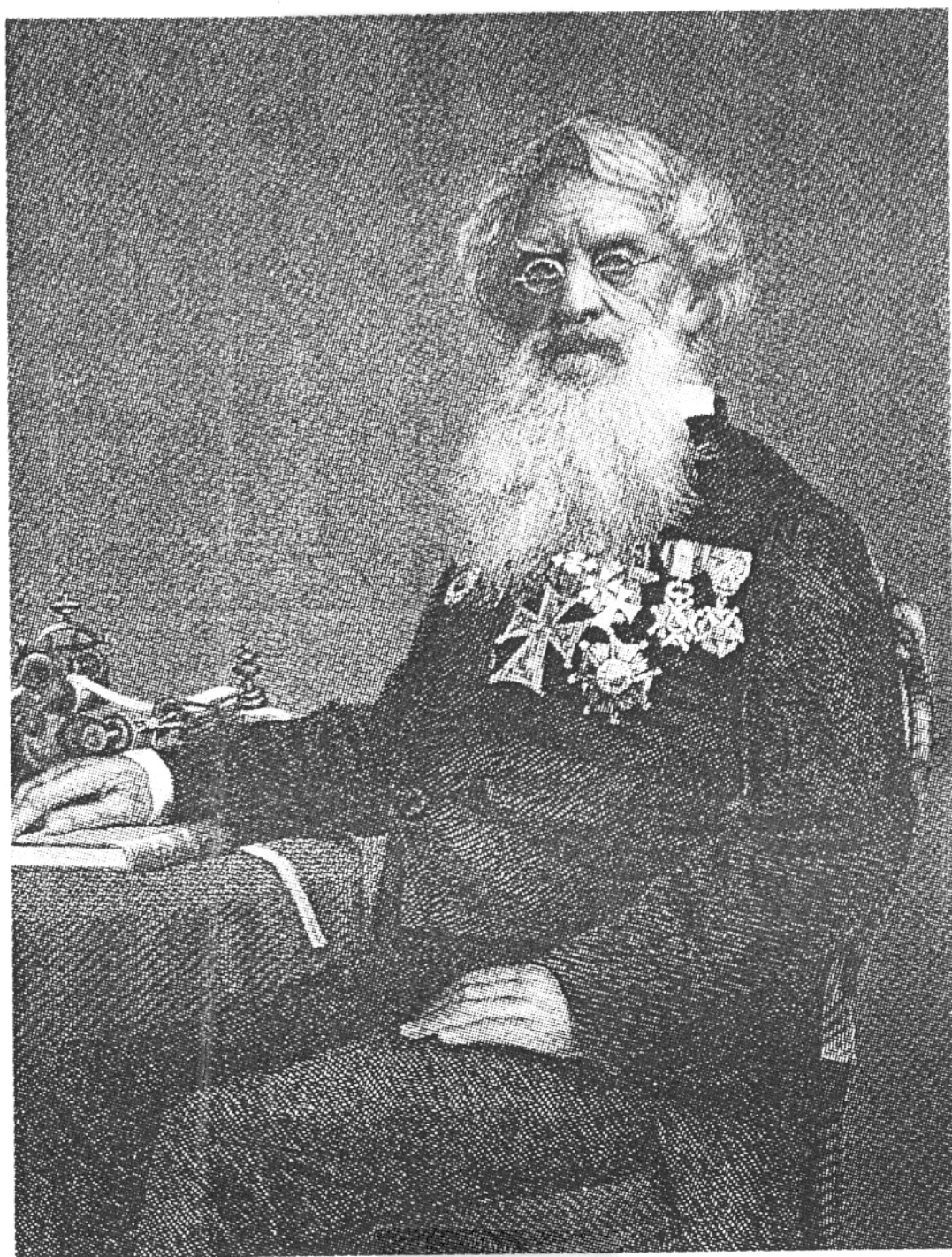
Codificación de textos: código Morse

A	.—	N	—.
B	—...	O	———
C	—.—.	P	.——.
D	—..	Q	——.—
E	.	R	.—.
F	..—.	S	...
G	——.	T	—
H	....	U	..—
I	..	V	...—
J	.———	W	.——
K	—.—	X	—..—
L	.—..	Y	—.——
M	——	Z	——..