Principles of Communications
ECS 332

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8. PCM

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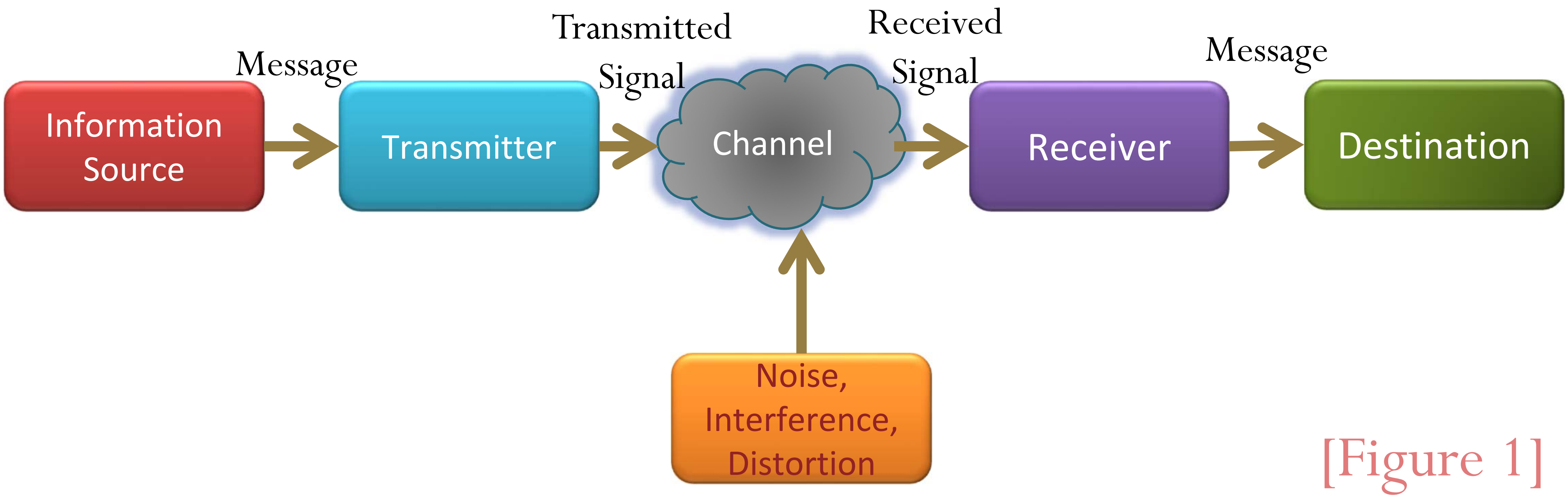
[Definition 1.2]

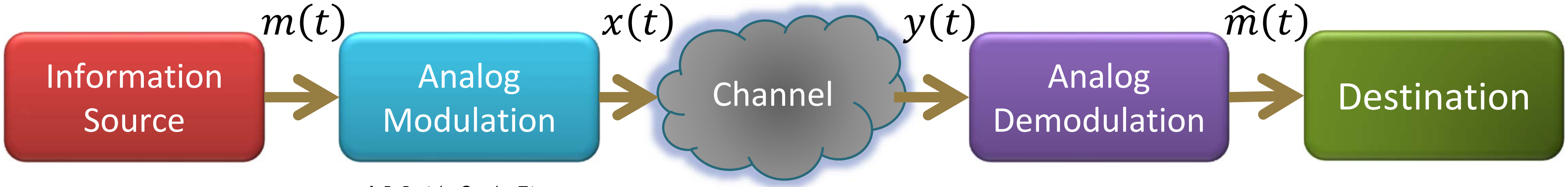
Basic elements of communication



[Figure 1]

CH 3-5

- Chapters 3-5

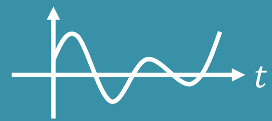


AM (4.3-4.5)
QAM (4.6)
FM,PM (CH5)

Sinusoidal Carrier: $A\cos(2\pi f_c t + \phi)$

Band-limited to B
Bounded by $\pm m_p$

Analog $m(t)$



AM: $x_{\mathrm{AM}}(t) = (A + m(t))\cos(2\pi f_c t + \phi)$

PM: $x_{\mathrm{PM}}(t) = A\cos\left(2\pi f_c t + \phi + k_p m(t)\right)$

$\frac{1}{2\pi}\frac{d}{dt}$

Useful for plotting $x_{\mathrm{PM}}(t)$ over the time intervals where $m(t)$ is differentiable.

$$f(t) = f_c + \frac{k_p}{2\pi}\frac{d}{dt}m(t)$$

FM: $x_{\mathrm{FM}}(t) = A\cos\left(2\pi f_c t + \phi + 2\pi k_f \int_{-\infty}^{t} m(\tau)d\tau\right)$

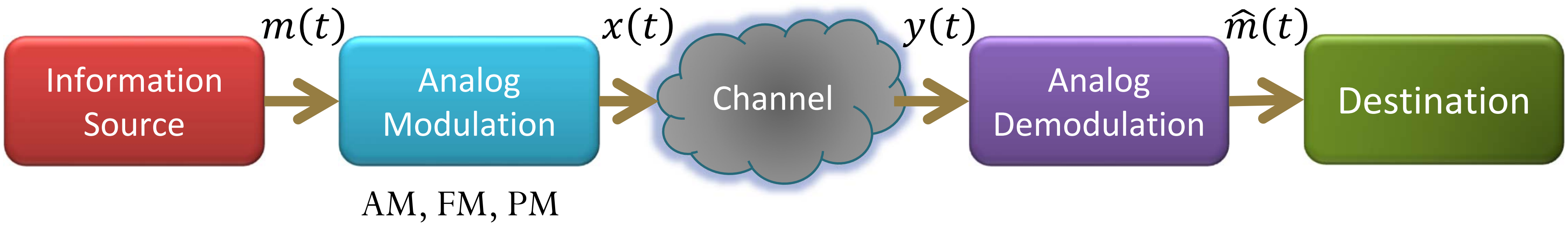
$2\pi\int$

$$f(t) = f_c + k_f m(t)$$

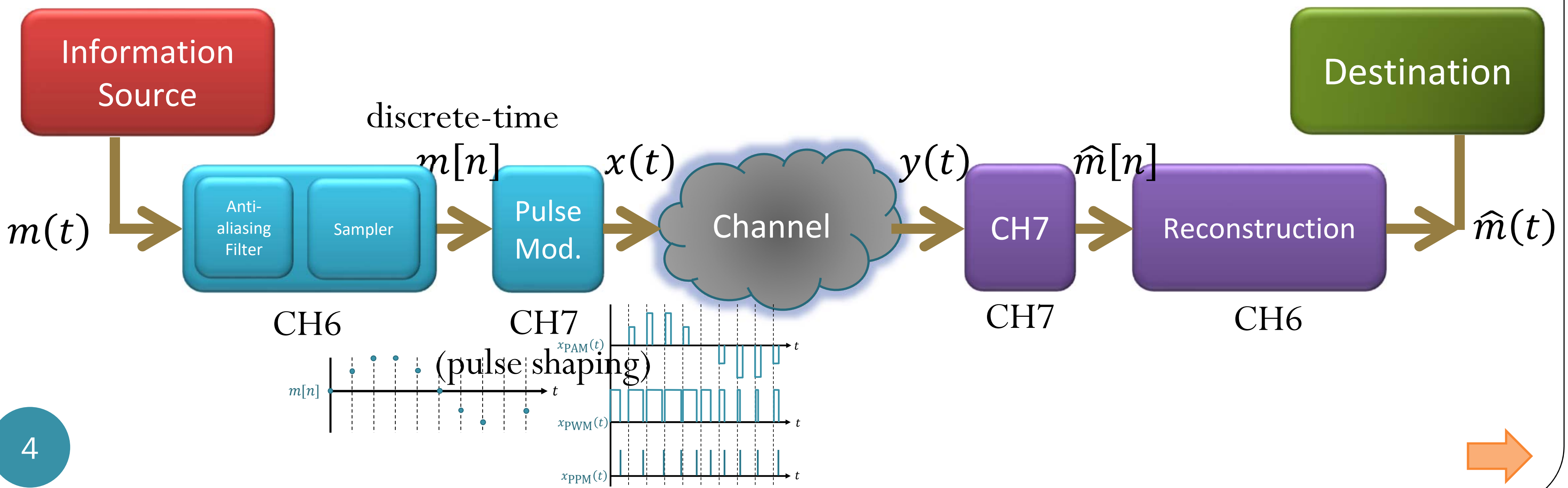
$$\begin{aligned} x_{\mathrm{QAM}}(t) &= m_1(t)\sqrt{2}\cos(2\pi f_c t) + m_2(t)\sqrt{2}\sin(2\pi f_c t) \\ &= \sqrt{2}E(t)\cos\left(2\pi f_c t + \phi(t)\right) \\ &= \sqrt{2}\left\{\left(m_1(t) - j m_2(t)\right)e^{j2\pi f_c t}\right\} \end{aligned}$$

CH 3-5 vs. CH 6-7

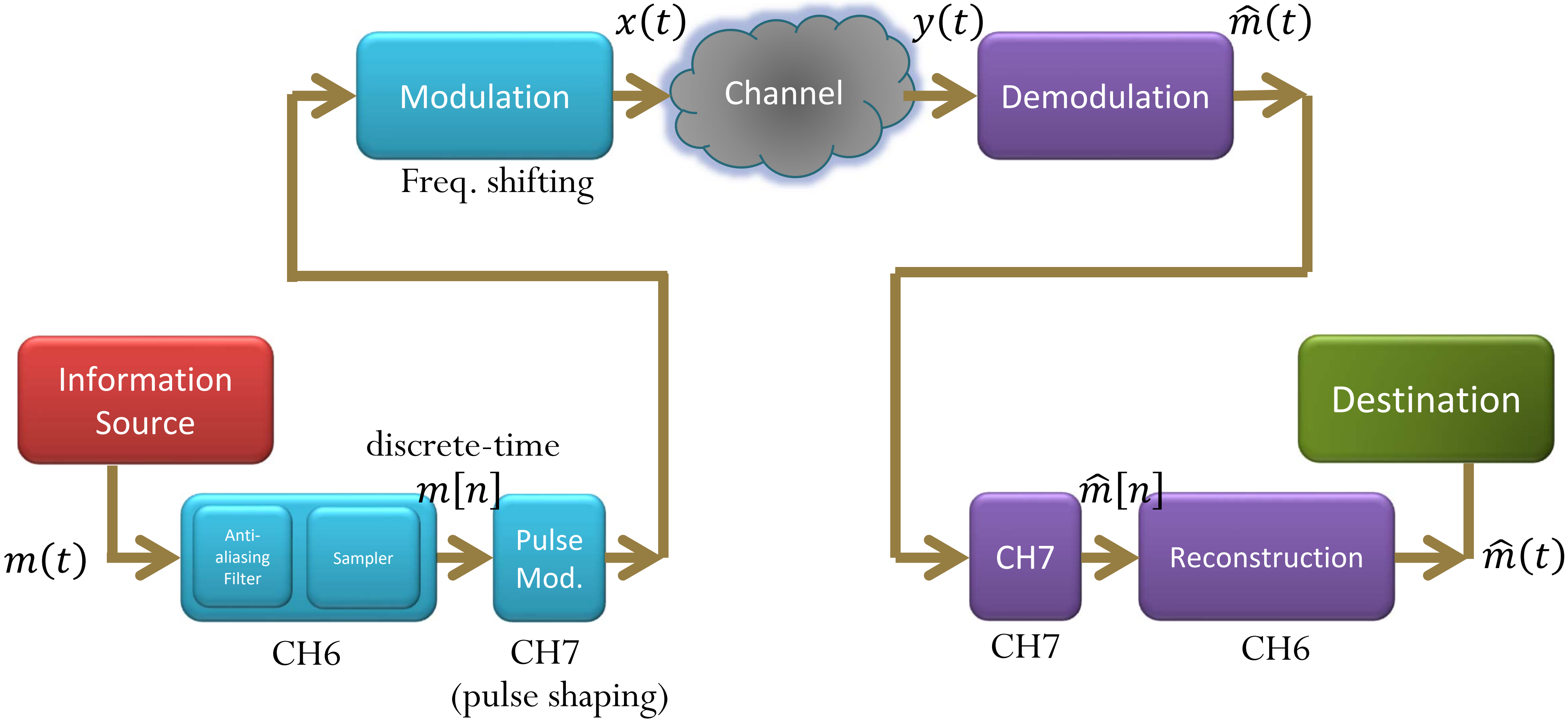
- Chapters 3-5



- Chapters 6-7

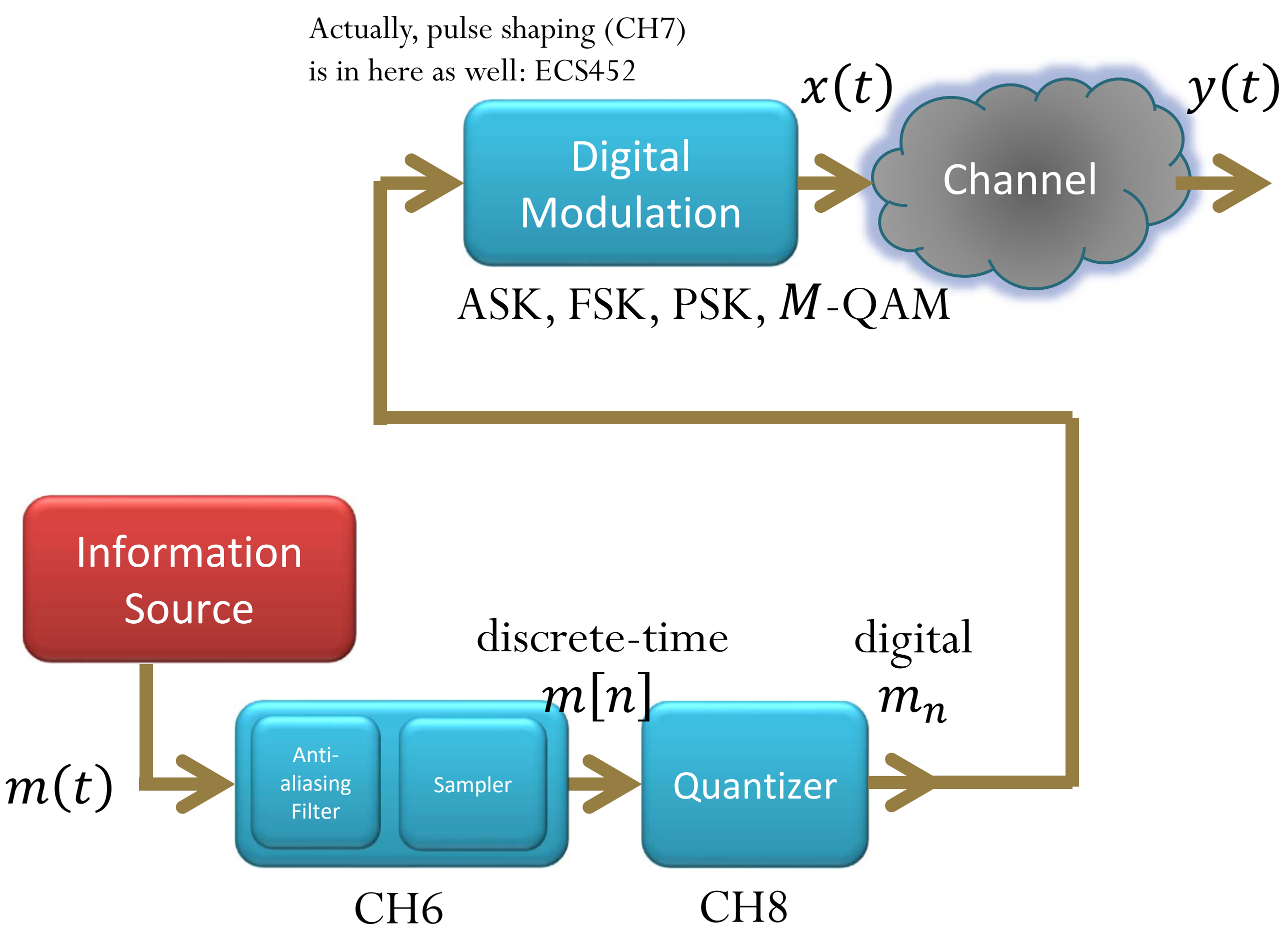


CH 3-5 + CH 6-7



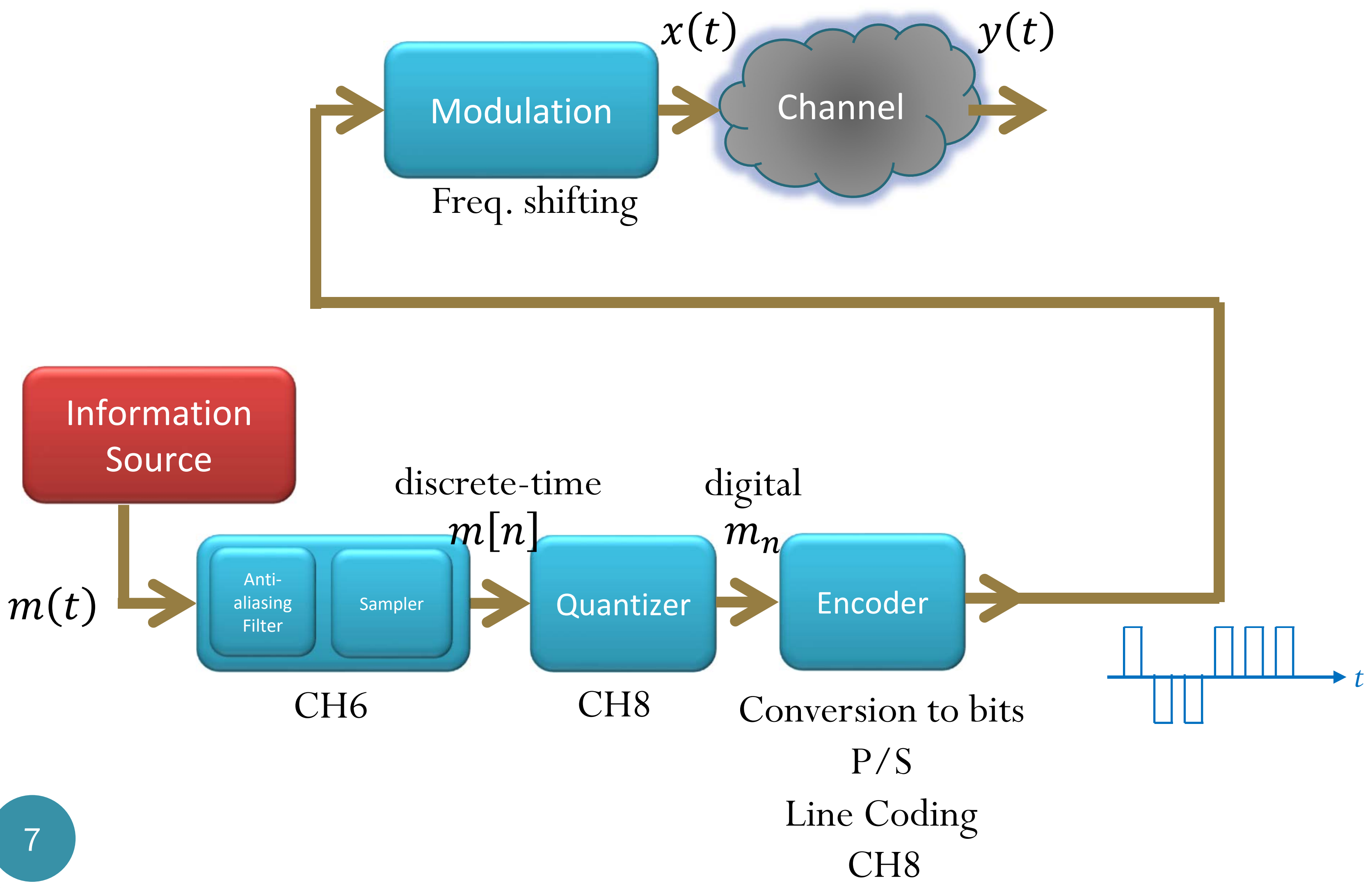
x(t)
y(t)
m̂(t)
Modulation
Channel
Demodulation
Freq. shifting
Information Source
discrete-time
m[n]
m(t)
Anti-aliasing Filter
Sampler
Pulse Mod.
CH6
CH7
(pulse shaping)
m̂[n]
CH7
Reconstruction
CH7
CH6
Destination
m̂(t)

CH 3-5 + CH 6 + CH 8



Actually, pulse shaping (CH7)
is in here as well: ECS452
Digital Modulation
$x(t)$
Channel
$y(t)$
ASK, FSK, PSK, M-QAM
Information Source
discrete-time
$m[n]$
digital
m_n
$m(t)$
Anti-aliasing Filter
Sampler
Quantizer
CH6
CH8

CH 3-5 + CH 6 + CH 8



$x(t)$
$y(t)$
Modulation
Channel
Freq. shifting
Information Source
discrete-time
digital
$m[n]$
m_n
$m(t)$
Anti-aliasing Filter
Sampler
Quantizer
Encoder
t
CH6
CH8
Conversion to bits
P/S
Line Coding
CH8

From ECS315

10.4.1 (Continuous) Uniform Distribution

(a, b)
[a, b)
(a, b]

Definition 10.44.

- The (continuous) uniform distribution on an interval $[a, b]$, is denoted by uniform$([a, b])$ or $\mathcal{U}([a, b])$ or simply $\mathcal{U}(a, b)$.

Ex. The RV generated by MATLAB's rand command is $\mathcal{U}(0,1)$

Exercise 10.51. Show that when $X \sim \mathcal{U}(a, b)$, $\mathbb{E}X = \frac{a+b}{2}$, $\operatorname{Var} X = \frac{(b-a)^2}{12}$, and $\mathbb{E}\left[X^2\right] = \frac{1}{3}\left(b^2 + ab + a^2\right)$.