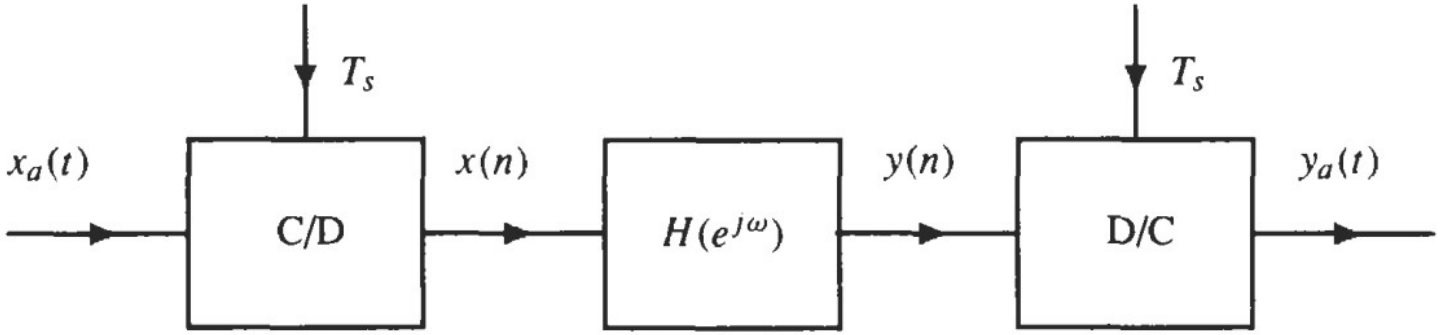
# Discrete- Time Processing of Analog Signals and Rate Conversion

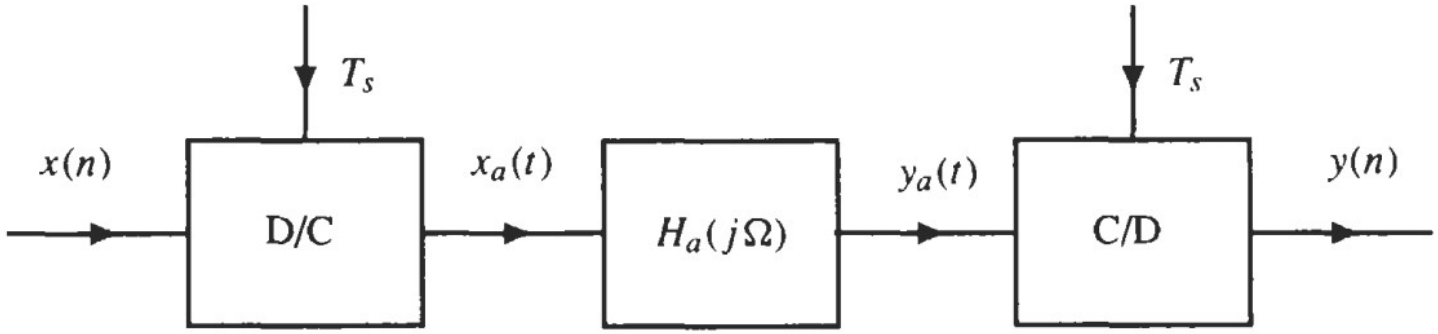
LECTURE 2

# Processing an analog signal using a discrete-time system.



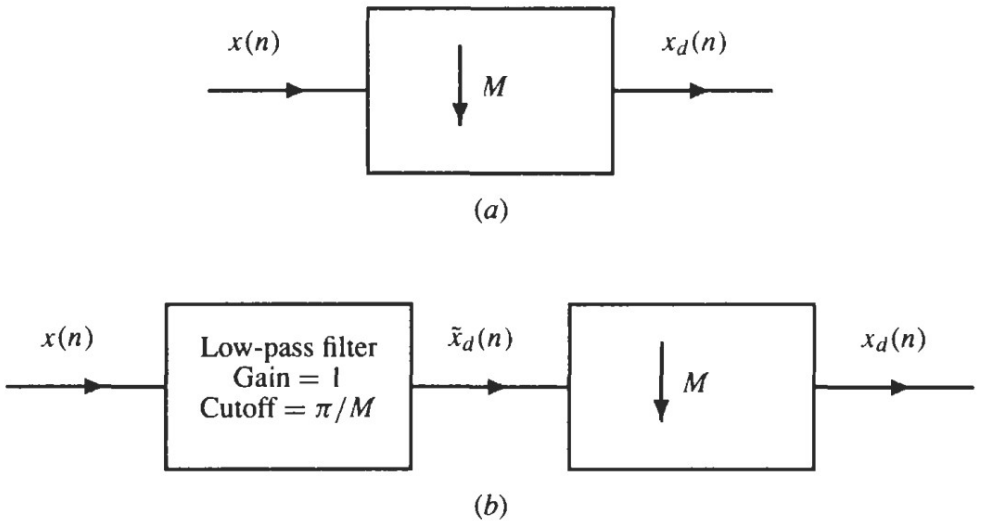

Processing an analog signal using a discrete-time system.

# Processing a discrete-time signal using a continuous-time system.



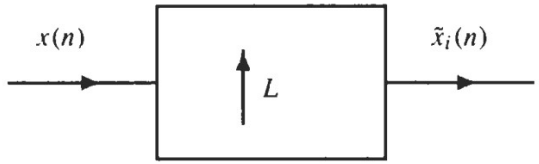

Processing a discrete-time signal using a continuous-time system.

# Sample Rate Reduction by an Integer Factor

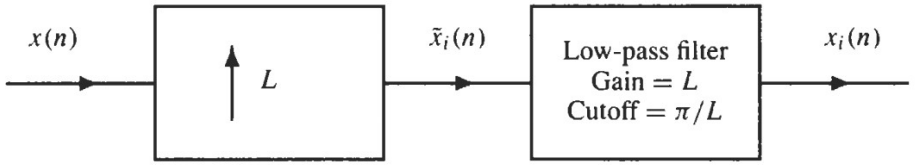



(*a*) Down-sampling by an integer factor $M$. (*b*) Decimation by a factor of $M$, where $H(e^{j\omega})$ is a low-pass filter with a cutoff frequency $\omega_c = \pi/M$.

# Sample Rate Increase by an Integer Factor



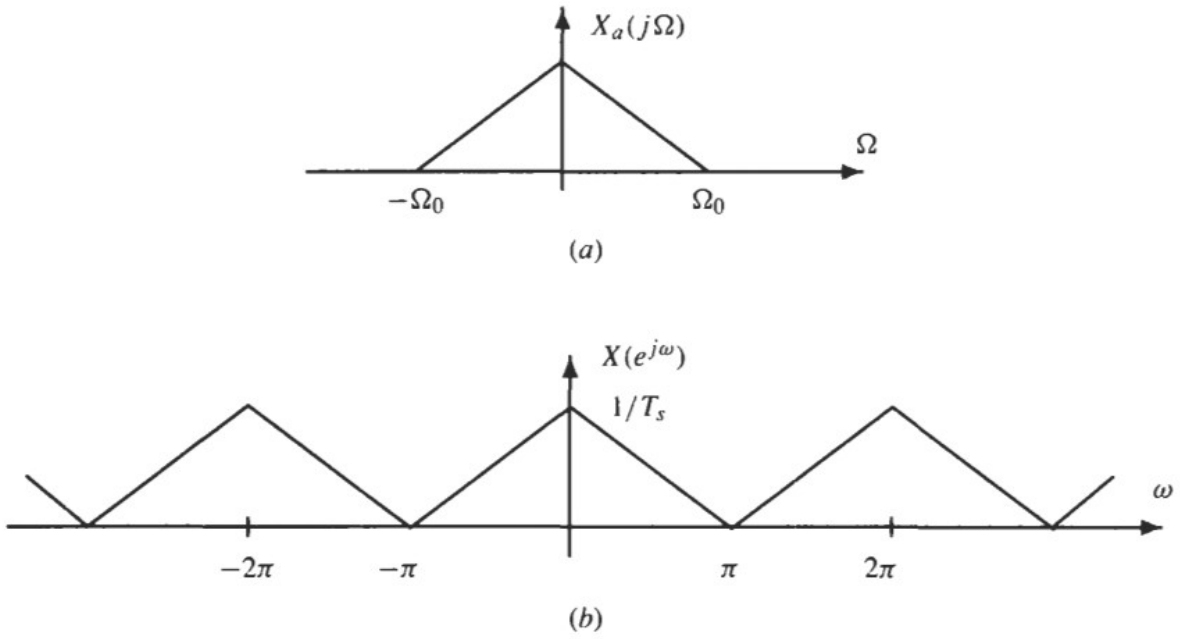

(a)




(b)

(a) Up-sampling by an integer factor $L$. (b) Interpolation by a factor of $L$.

# Example

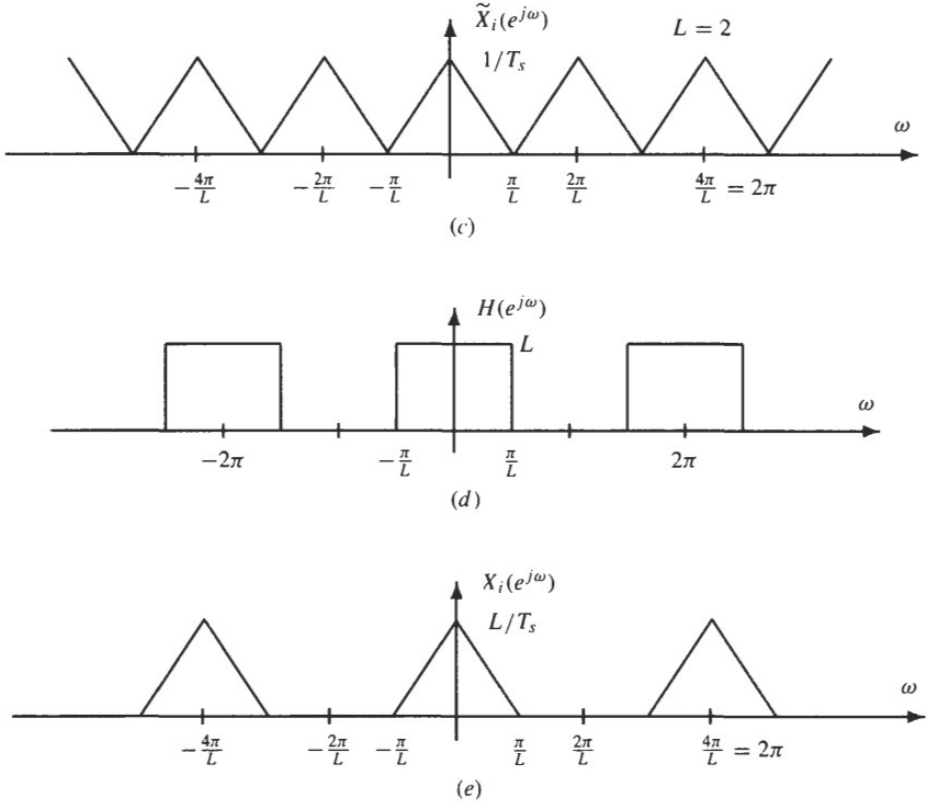



Frequency domain illustration of the process of interpolation.

(a) The continuous-time signal.

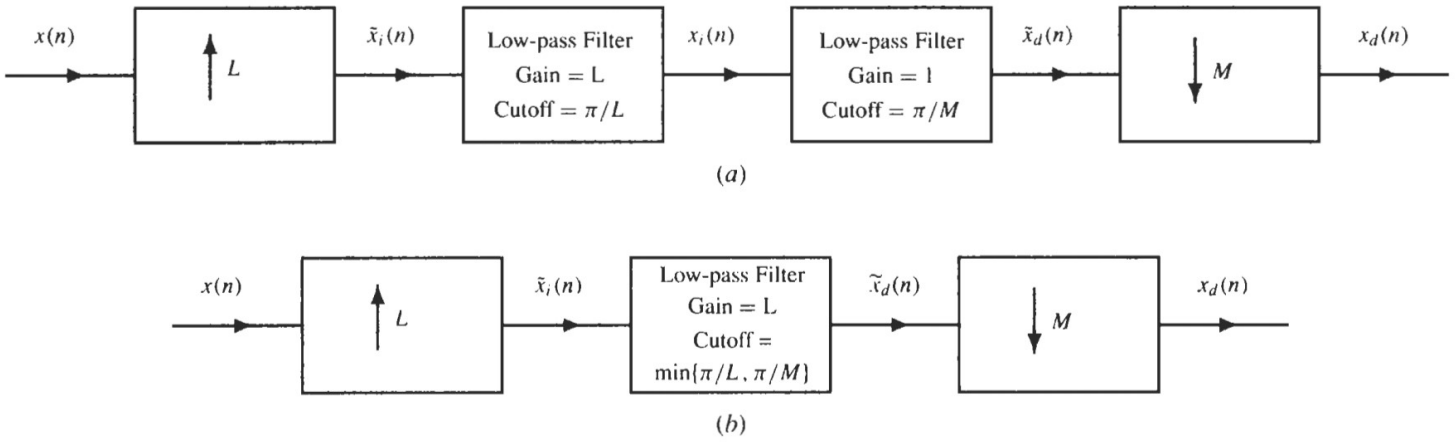
(b) (b) The DTFT of the sampled signal $x(n) = x_a(nT_s)$.

# Example




(c) The DTFT of the up-sampler output.
(d) The ideal low-pass filter to perform the interpolation.
(e) The DTFT of the interpolated signal.

# Sample Rate Conversion by a Rational Factor




(*a*) Cascade of an interpolator and a decimator for changing the sampling rate by a rational factor $L/M$. (*b*) A simplified structure that results when the two low-pass filters are combined.