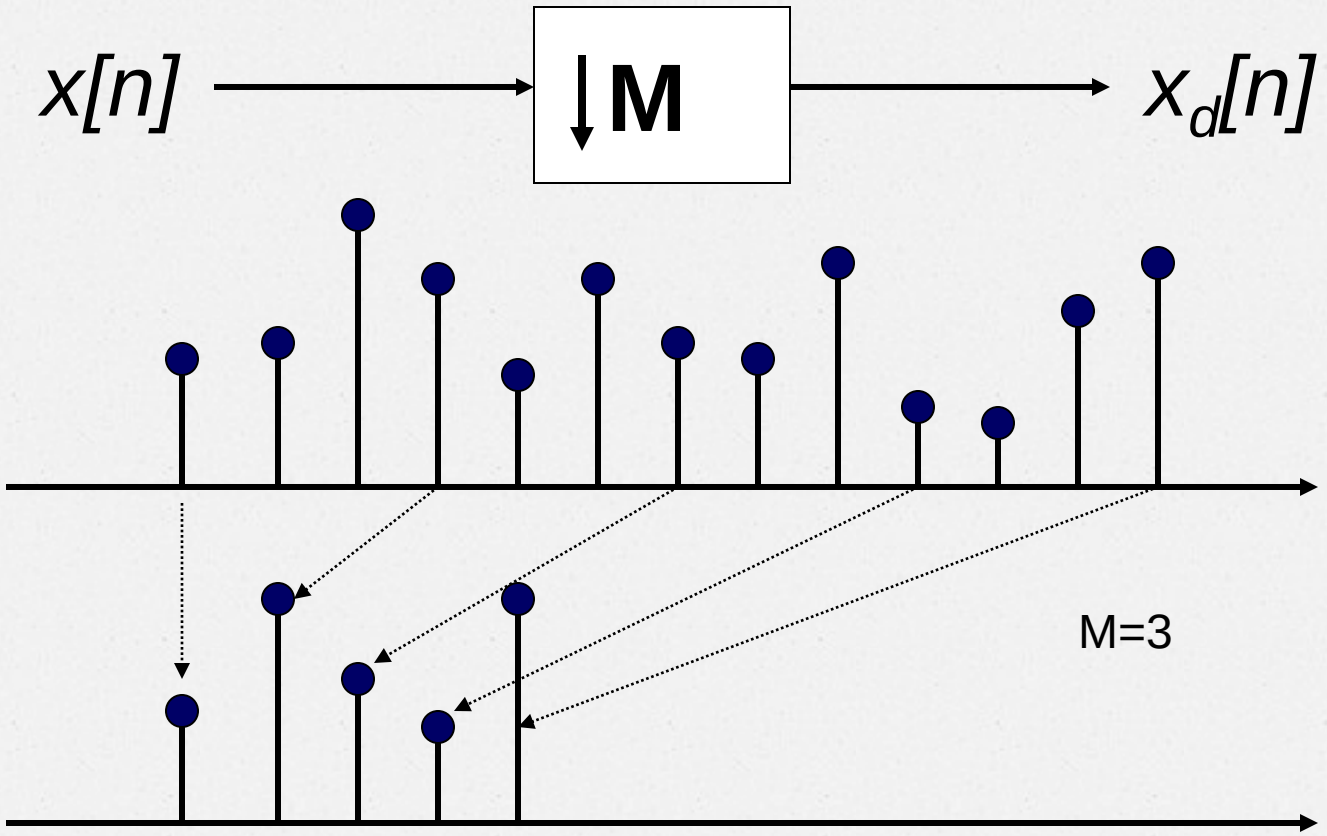
Digital Signal Processing- Lecture 14

Topics to be covered:

- Multirate Digital Signal Processing

Decimation System (Down Sampling)



Decimation System (Down Sampling)

$x_d[n] = x[nM]$, where M is an integer

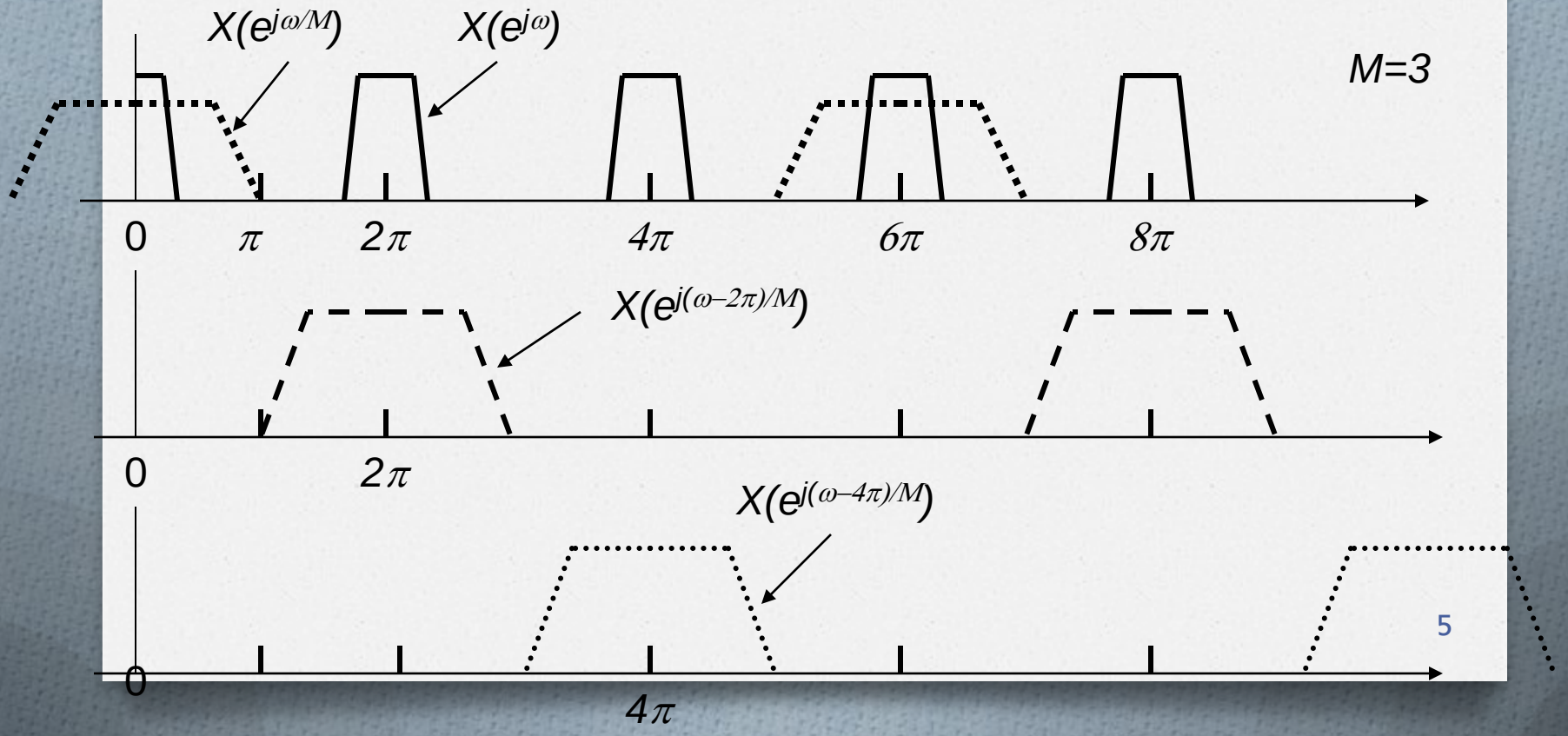
$$X_d(z) = \Sigma_n x_d[n] z^{-n}$$

$$= (1/M) \Sigma_{m=0,(M-1)} X(z^{(1/M)} e^{-jm2\pi/M})$$

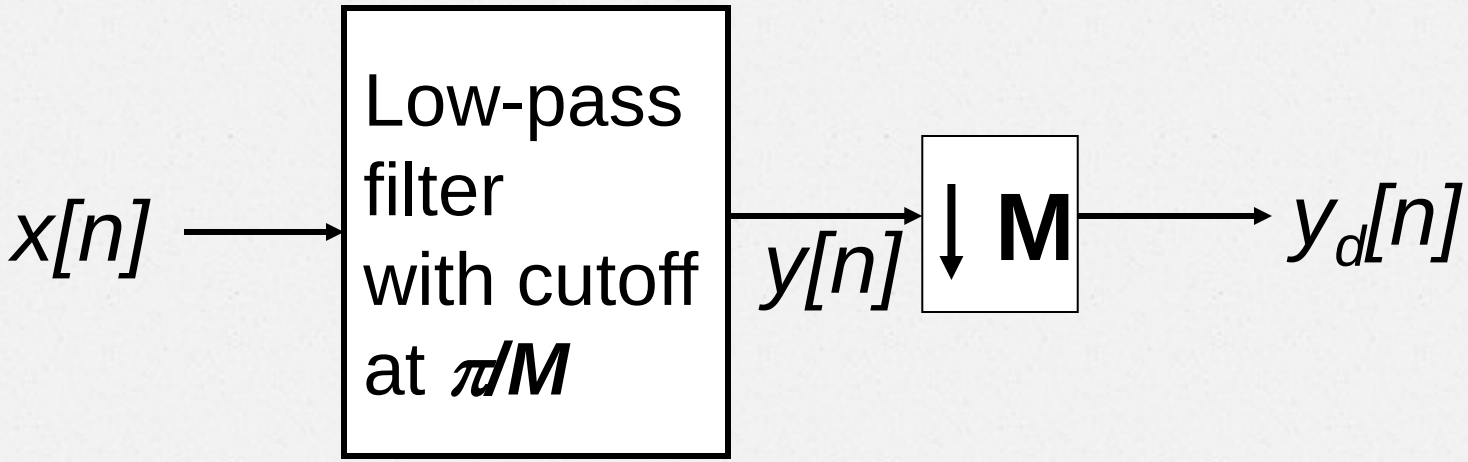
$$X_d(e^{j\omega}) = (1/M) \Sigma_{m=0,(M-1)} X(e^{j(\omega - m2\pi)/M})$$

Decimation System (Down Sampling)

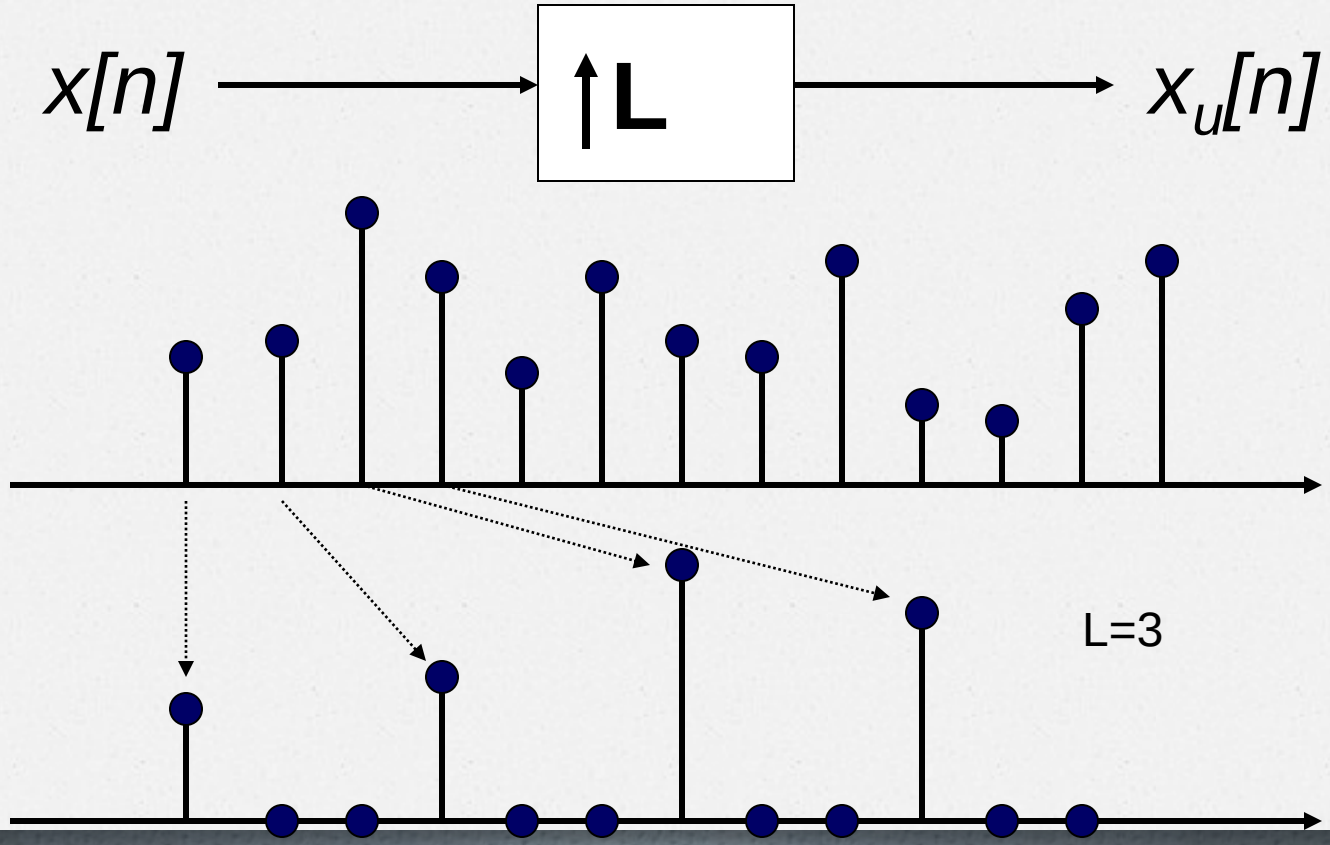
$$X_d(e^{j\omega}) = (1/M)\,\Sigma_{m=0,(M-1)}\, X(e^{j(\omega - m2\pi)/M})$$



Sampling Rate Reduction System



Interpolation System (Up Sampling)



Interpolation System (Up Sampling)

$$x_u[n] = \begin{cases} x[n/L], & n = 0, \pm L, \pm 2L, \ldots \\ 0, & otherwise \end{cases}$$

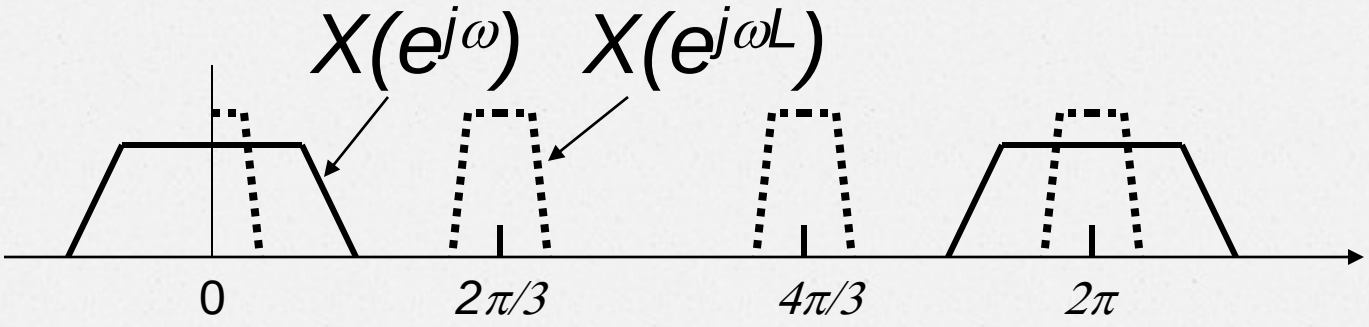
$$X_u(z) = \Sigma_n x_u[n] z^{-n} = X(z^L)$$

$$X_u(e^{j\omega}) = X(e^{j\omega L})$$

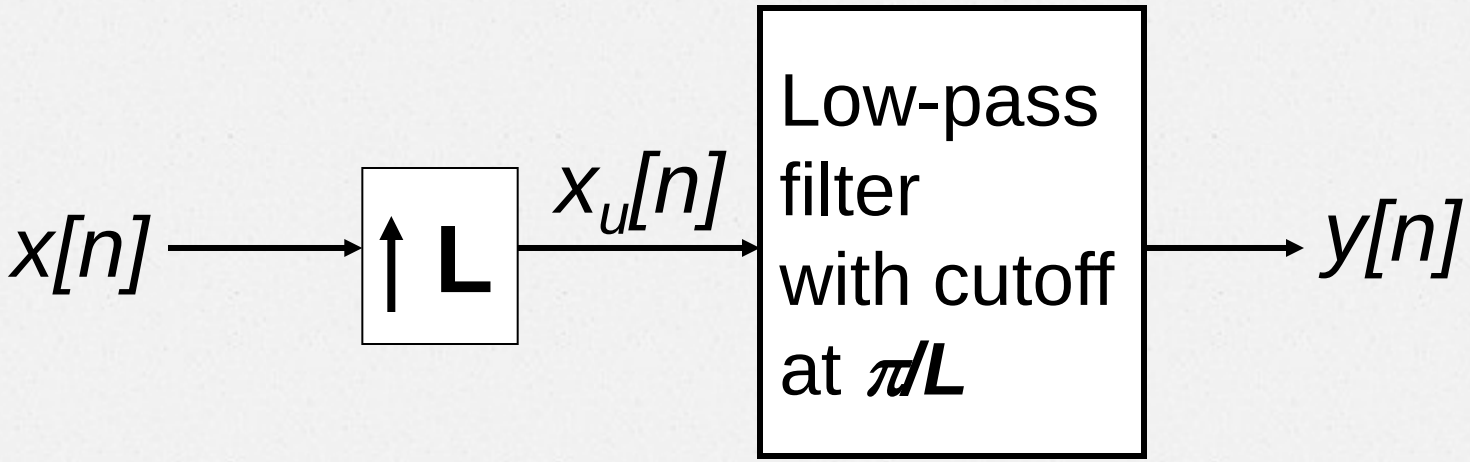
Interpolation System (Up Sampling)

$$X_u(e^{j\omega}) = X(e^{j\omega L})$$

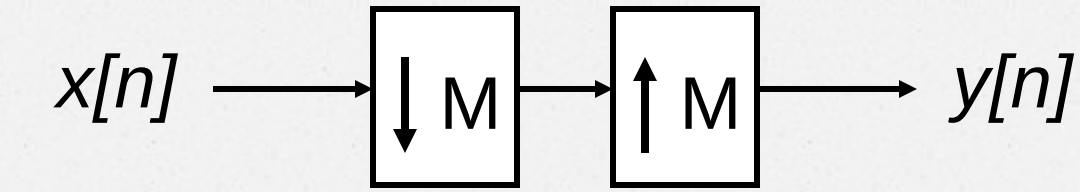
$L=3$



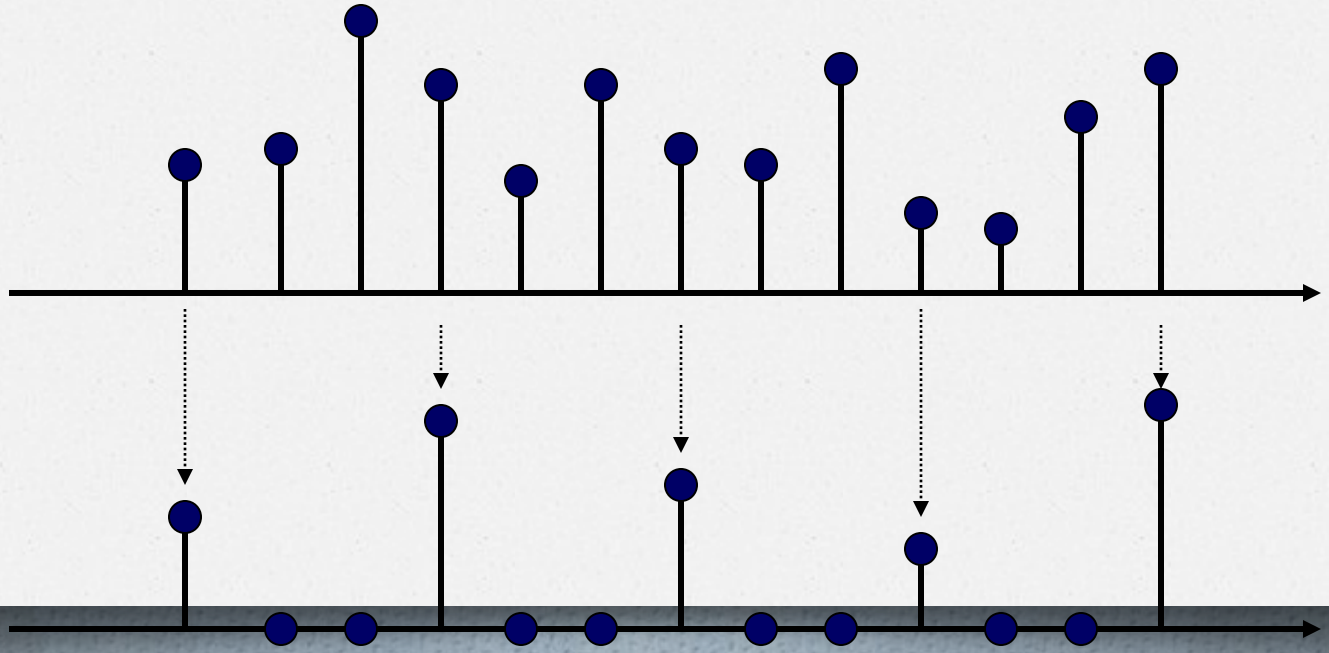
Sampling Rate Increase System



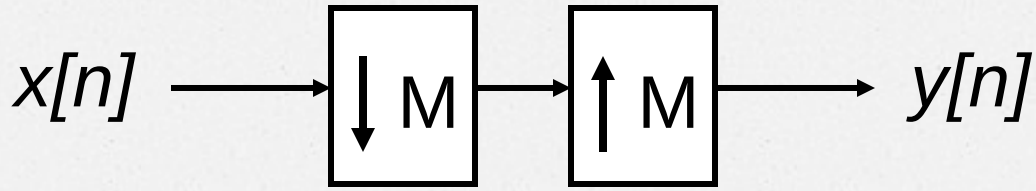
Decimation and Interpolation



M=3



Decimation and Interpolation



Let $W_M = e^{-j2\pi/M}$

$$Y(z) = (1/M)\Sigma_{m=0,(M-1)}\ X(ze^{-jm2\pi/M})$$

$$= (1/M)\Sigma_{m=0,(M-1)}\ X(zW_M^{m})$$

$$Y(e^{j\omega}) = (1/M)\Sigma_{m=0,(M-1)}\ X(e^{j(\omega-m2\pi/M)})$$

Decimation and Interpolation

$$Y(e^{j\omega}) = (1/M)\,\Sigma_{m=0,(M-1)}\; X(e^{j(\omega - jm2\pi/M)})$$