電子回路論 第５回
Electric Circuit No.5

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Zeros and Poles of Transfer Functions

$$W(s) = B\frac{(s-\beta_1)\cdots(s-\beta_m)}{(s-\alpha_1)\cdots(s-\alpha_n)}$$

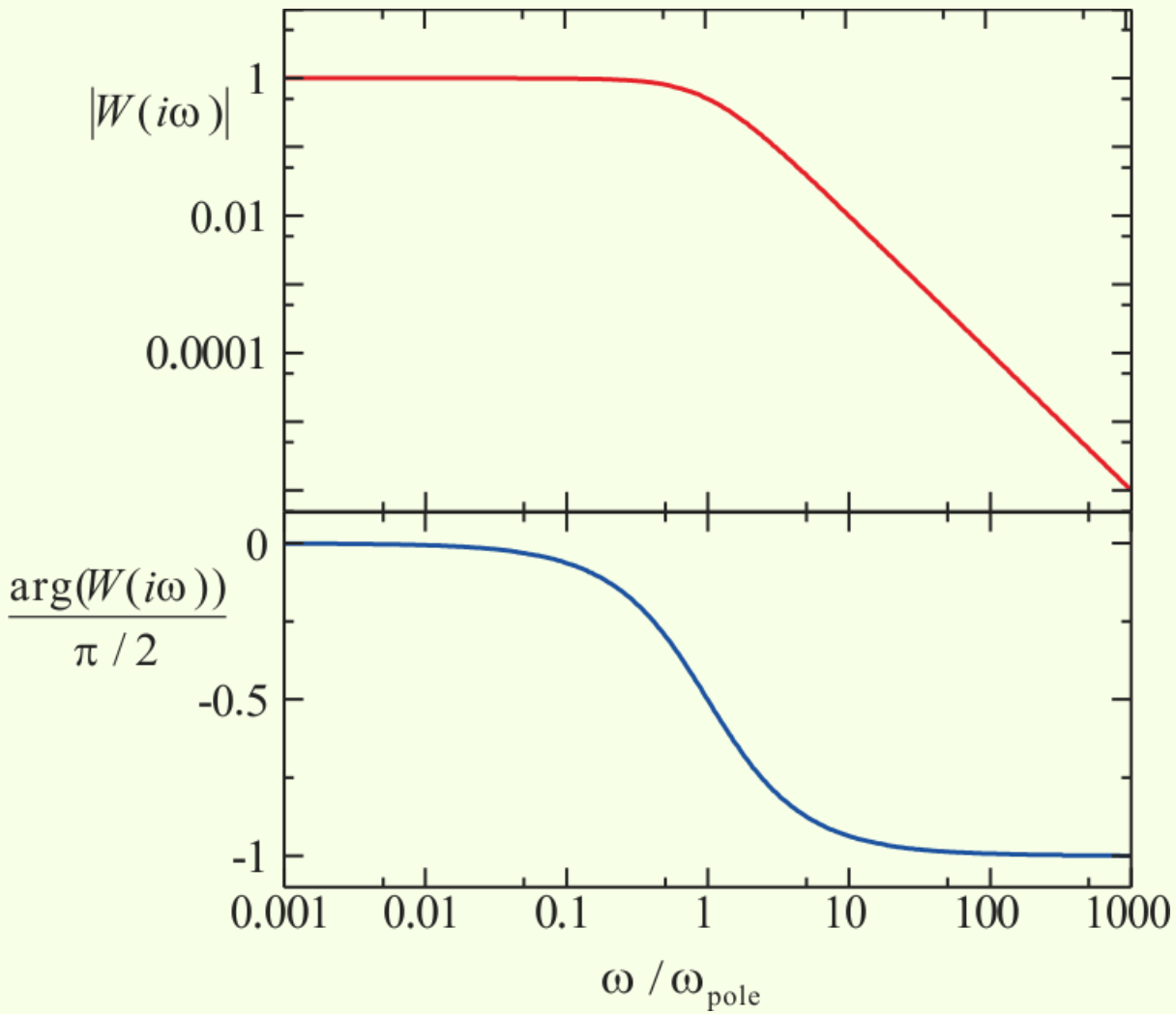
$\{\alpha_j\}$: Poles $\{\beta_j\}$: Zeros

Bode diagram

$$\log|W(i\omega)| = \log|B| + \sum_{j=1}^{m}\log|(i\omega-\beta_j)| - \sum_{j=1}^{n}\log|(i\omega-\alpha_j)|,$$

$$\arg(W(i\omega)) = \arg(B) + \sum_{j=1}^{m}\arg(i\omega-\beta_j) - \sum_{j=1}^{n}\arg(i\omega-\alpha_j)$$

Effect of a Pole on the Real Axis for Bode Diagram



Effect of a Resonance Pole (Finite Imaginary Part)

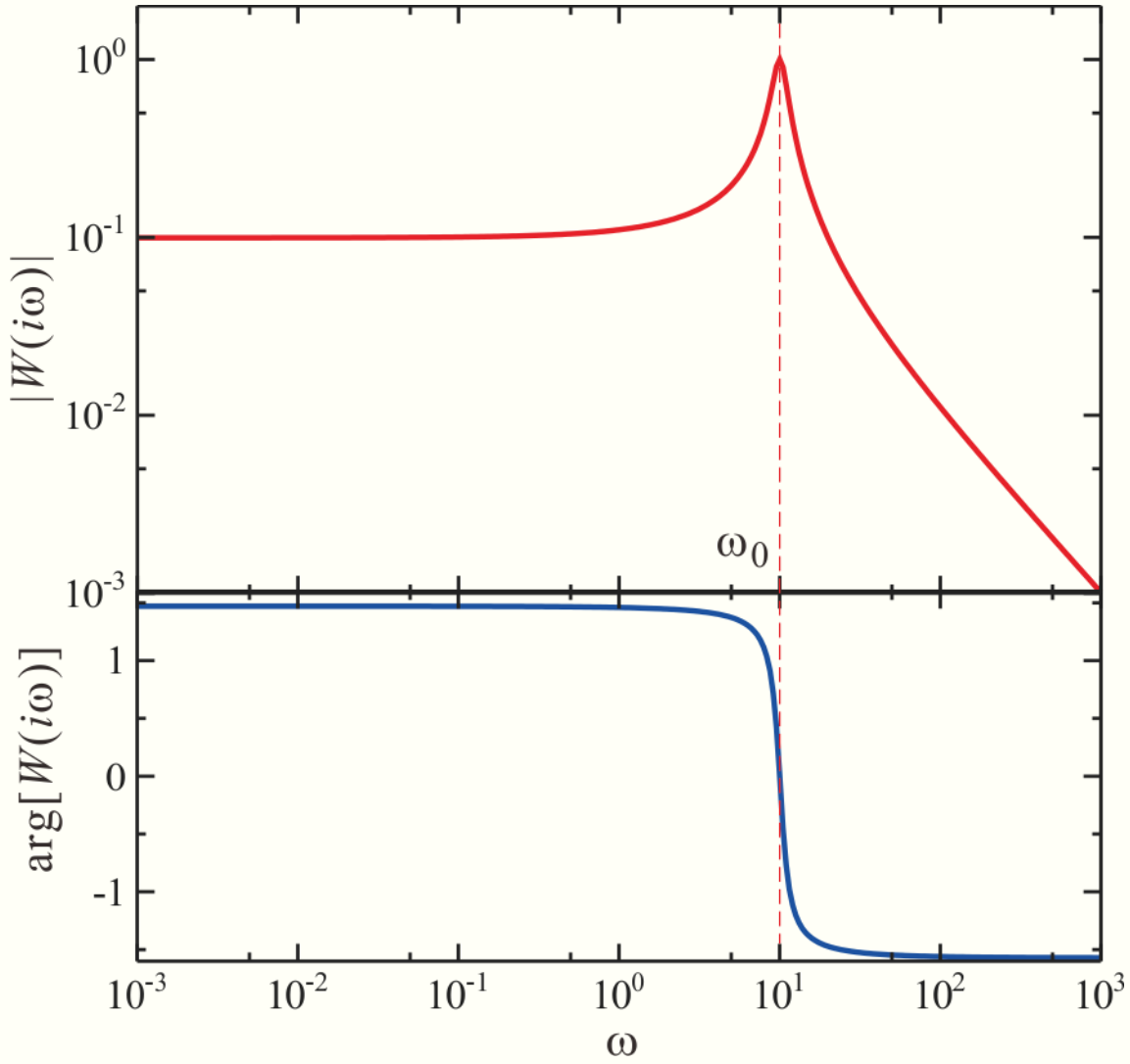
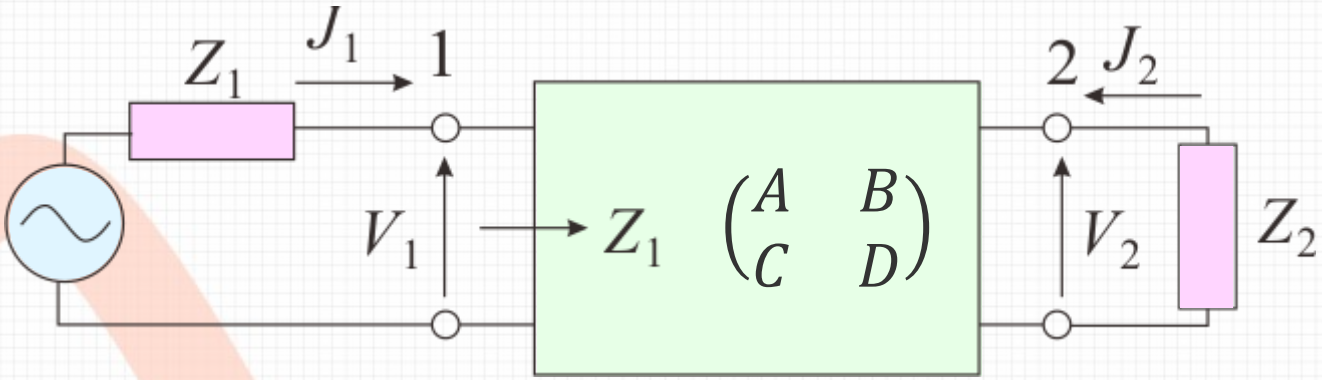


Image parameters



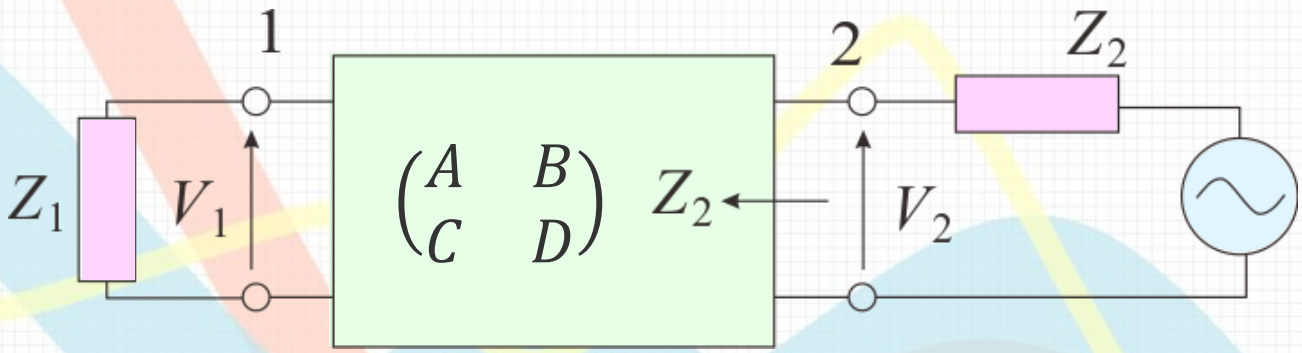


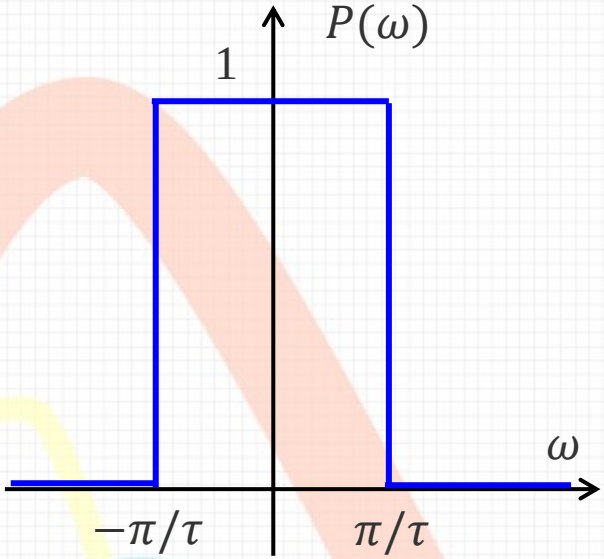
Image parameters

$$Z_1 = \sqrt{\frac{AB}{CD}}, \quad Z_2 = \sqrt{\frac{DB}{CA}}$$

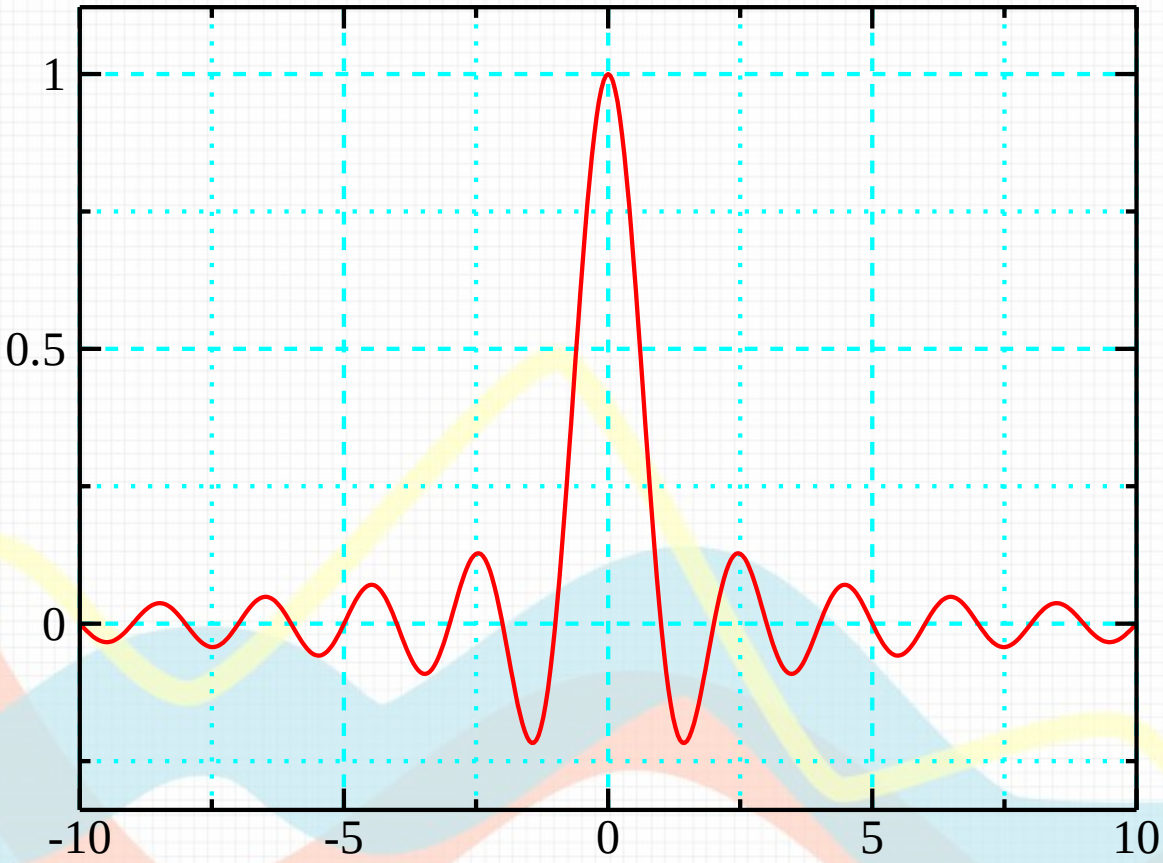
$$A = \sqrt{\frac{Z_1}{Z_2}} \cosh\theta, \quad B = \sqrt{Z_1 Z_2} \sinh\theta,$$

$$C = \frac{1}{\sqrt{Z_1 Z_2}} \sinh\theta, \quad D = \sqrt{\frac{Z_2}{Z_1}} \cosh\theta$$

Sinc function

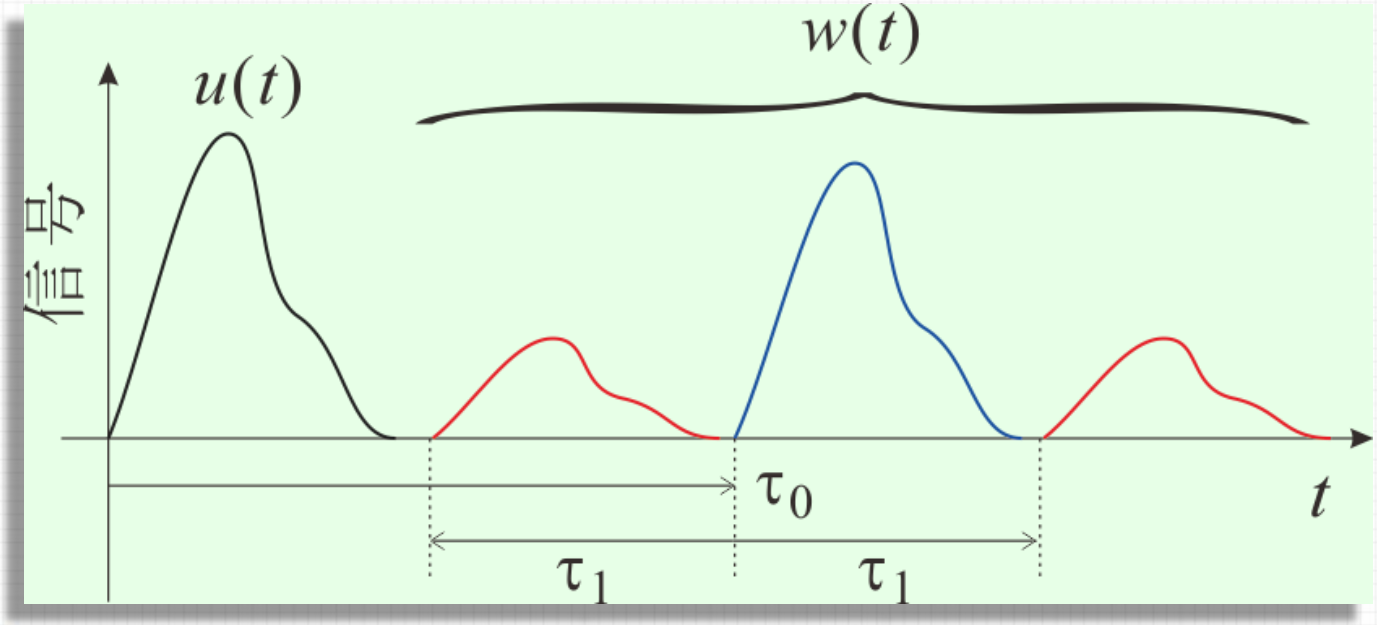


$$\operatorname{sinc}(x) = \frac{\sin \pi x}{\pi x}$$

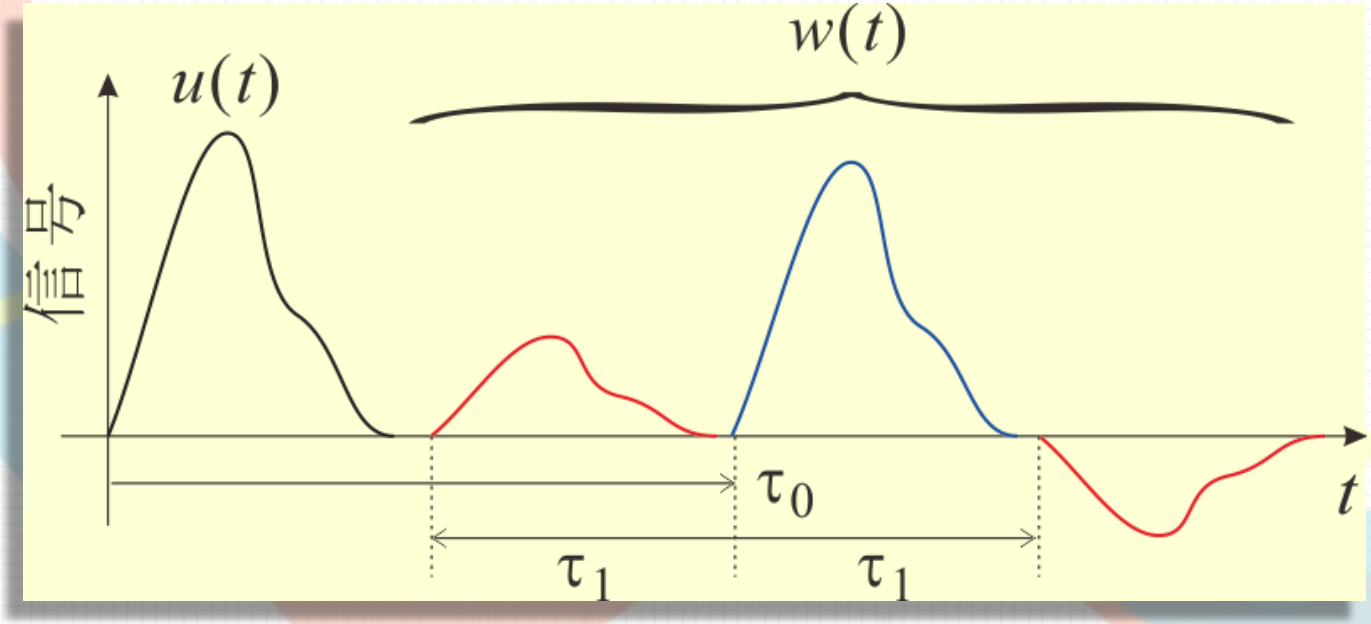


Distortion (paired echo)

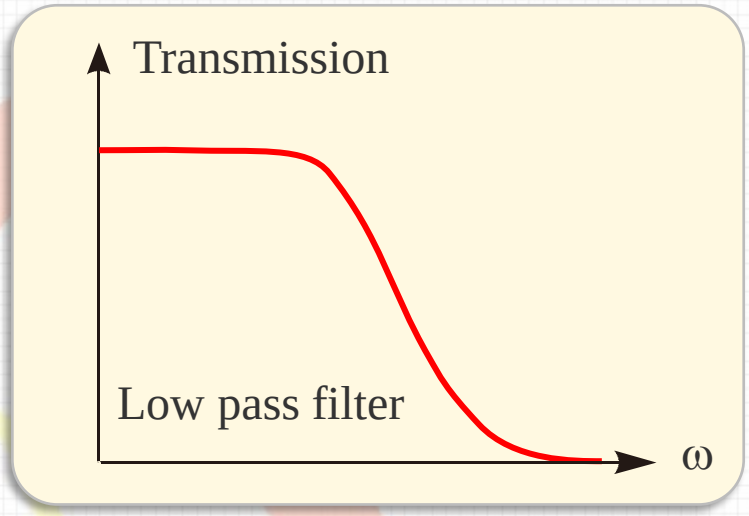
Cosine Amplitude Distortion

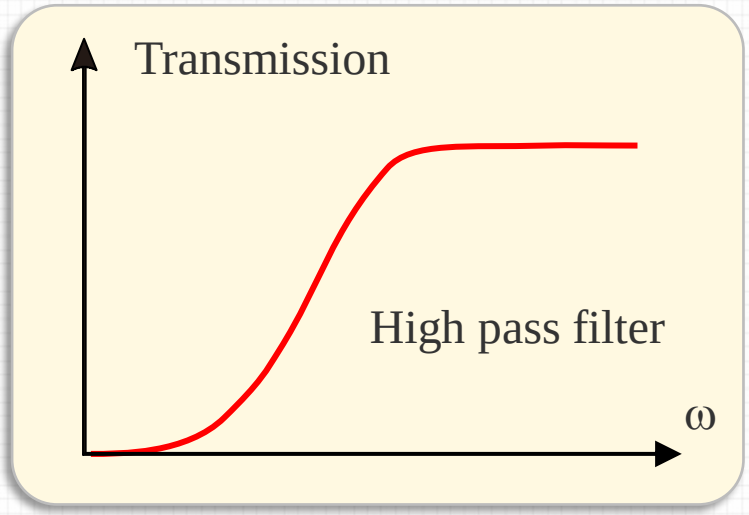


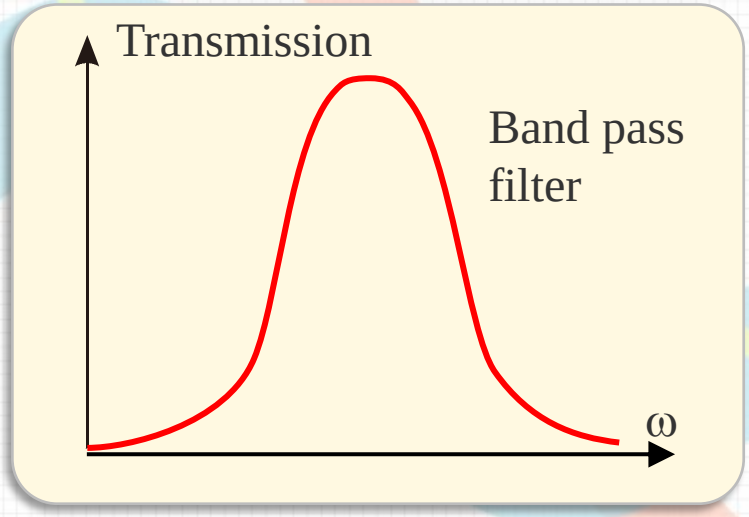
Sine Delay Distortion

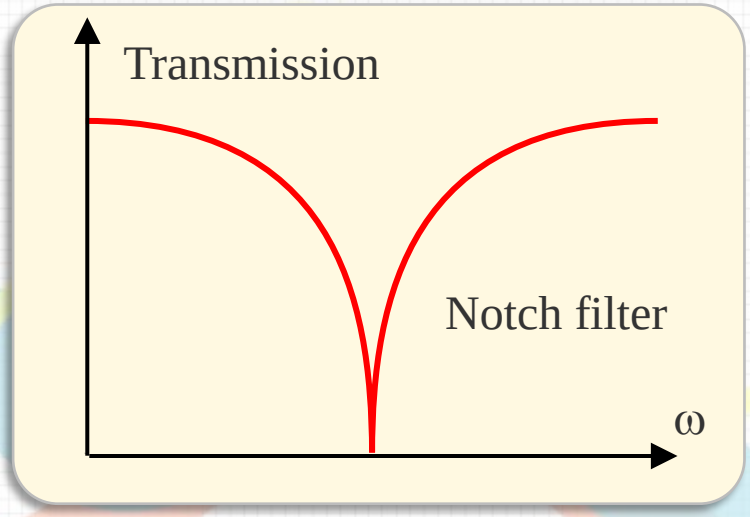


Filter Circuit



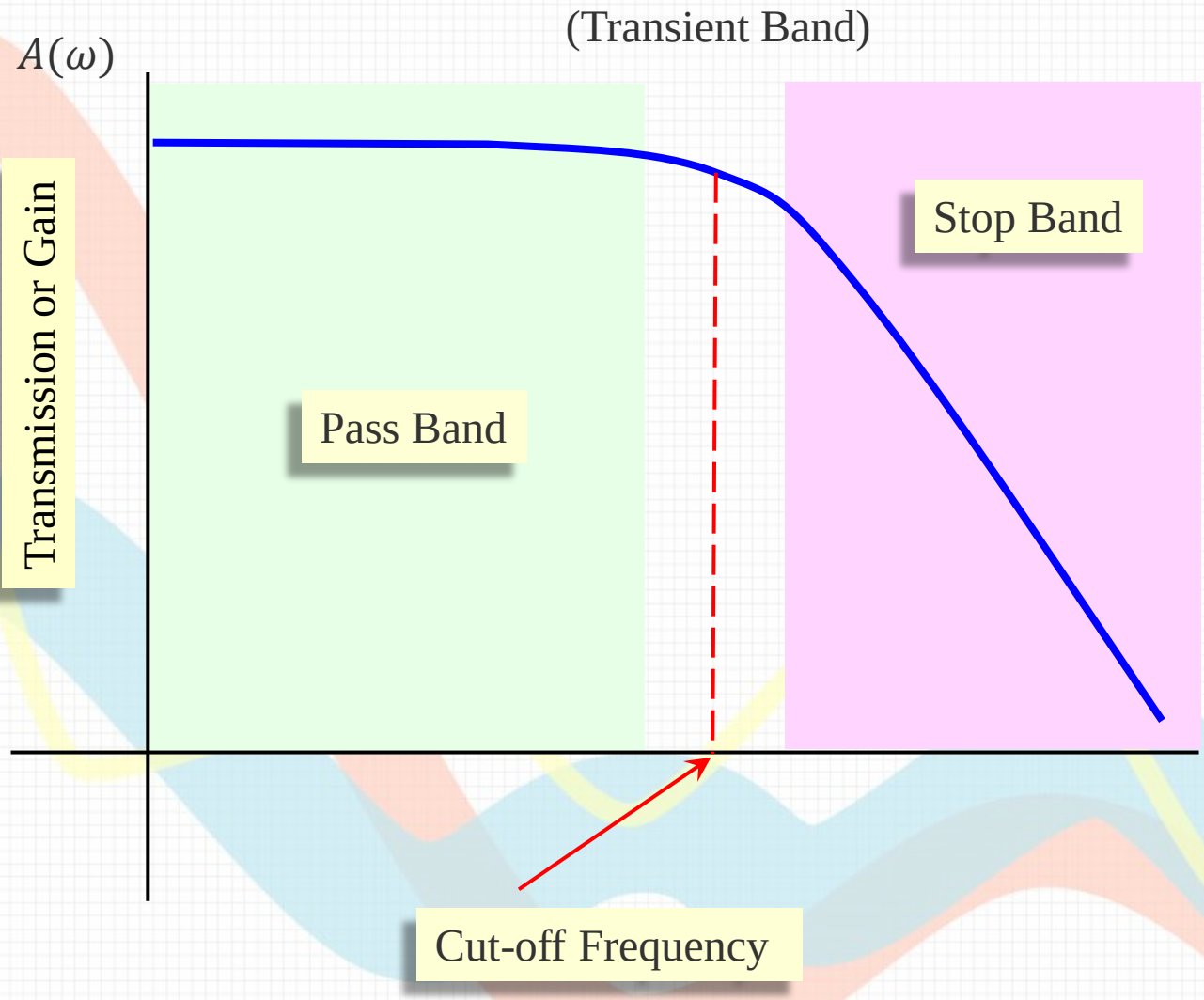




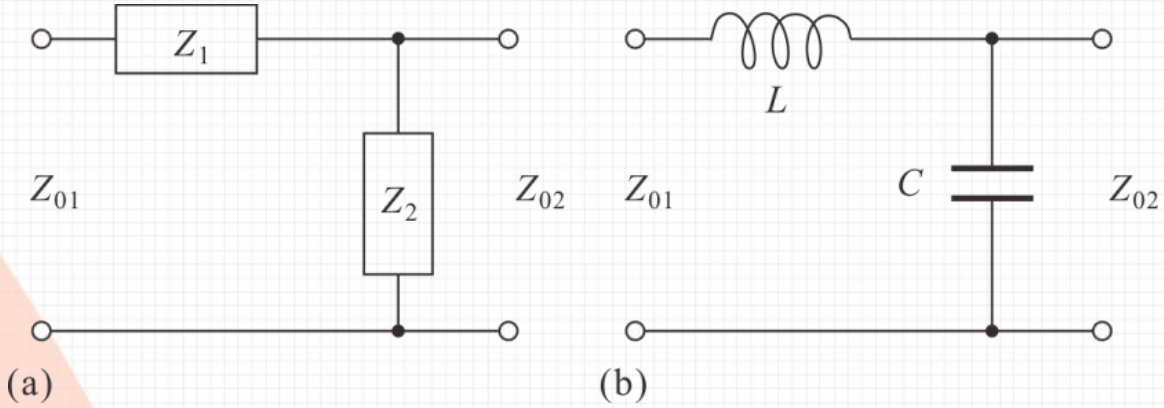


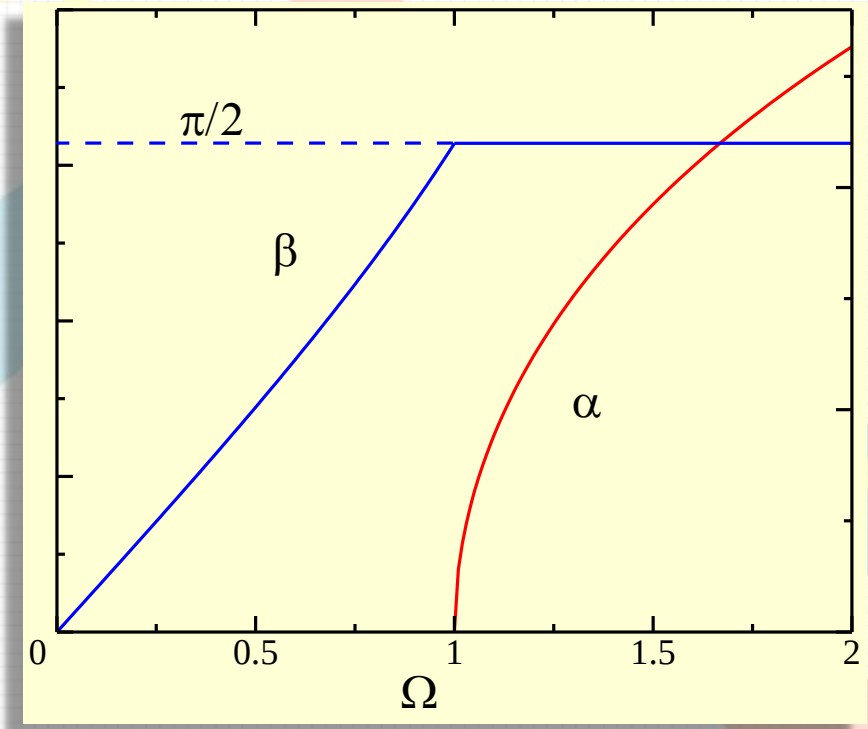
Terms for Filters

$$\Xi(i\omega) = A(\omega)e^{i\phi(\omega)}$$



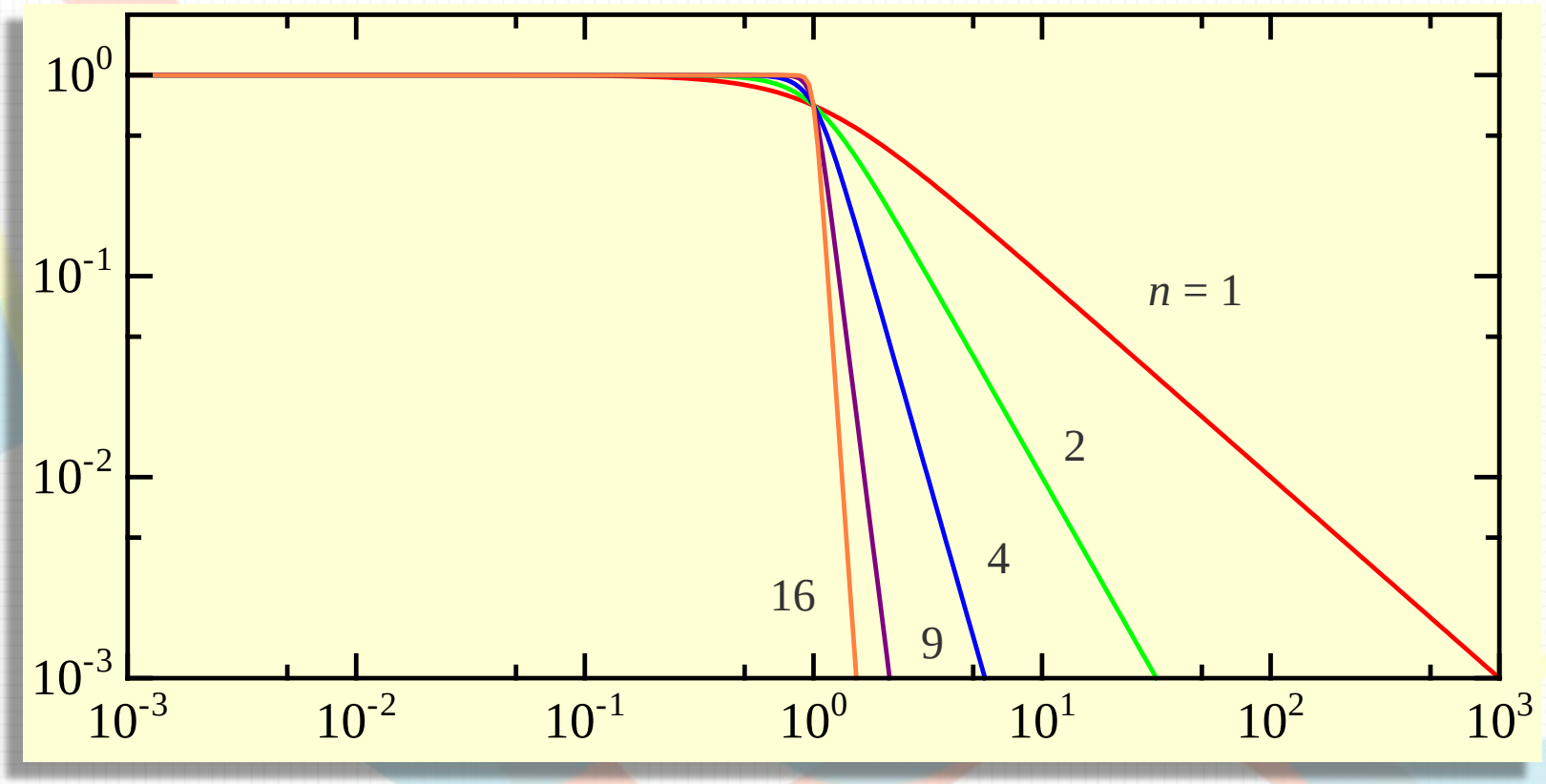
Constant K type filter





Butterworth Filter

$$G^2(i\omega/\omega_0) = |H(i\omega)|^2 = \frac{1}{1 + (\omega/\omega_0)^{2n}}$$



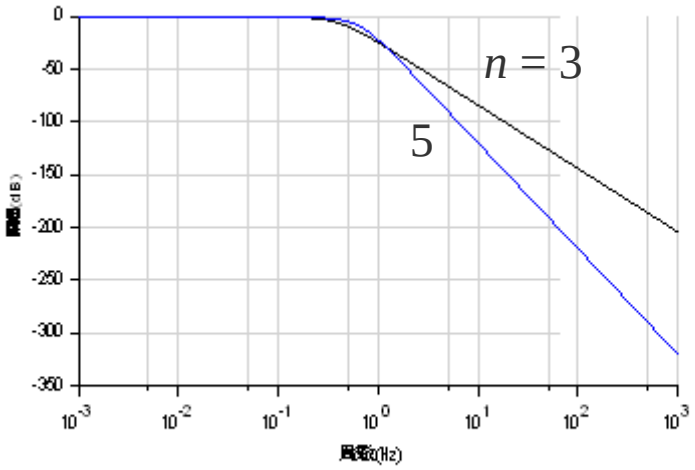
Bessel Filter

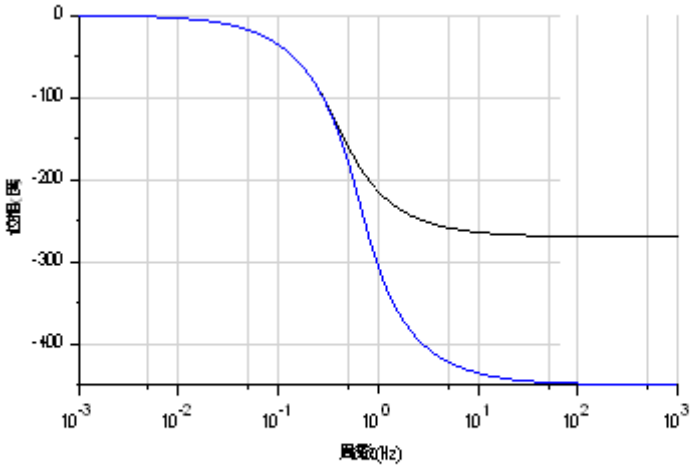
Inverse Bessel Polynomial

$$B_0 = 1, \quad B_1(s) = s + 1$$

$$B_n(s) = (2n-1)B_{n-1}(s) + B_{n-2}(s)s^2$$

$$\Xi(s) = \frac{B_n(0)}{B_n(s)}$$



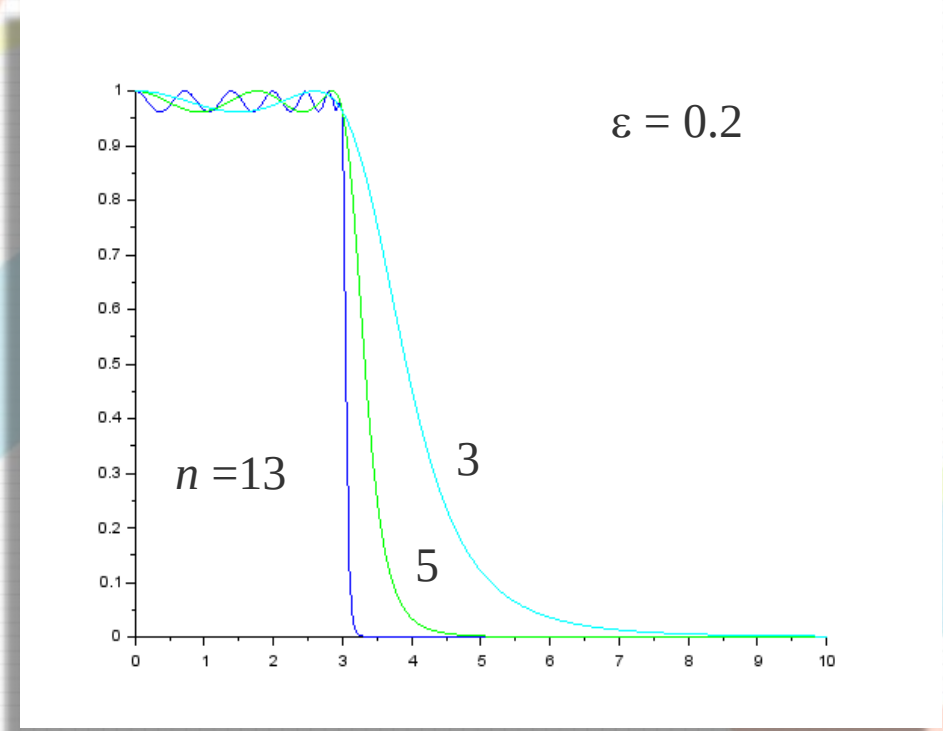


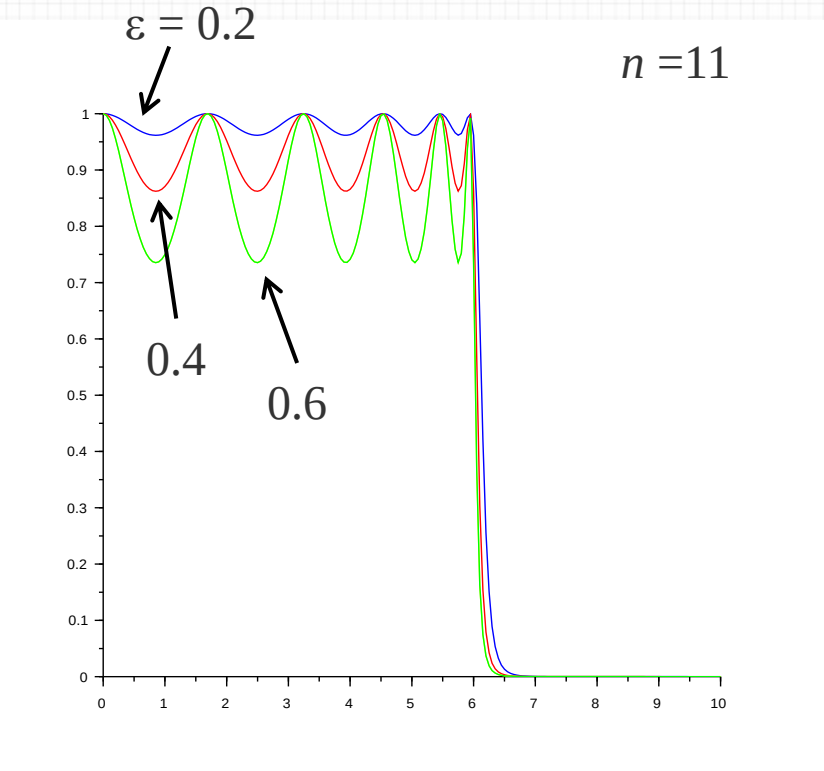
Chebyshev Filter

$$G_n(i\Omega) = |H_n(i\Omega)| = \frac{1}{\sqrt{1+\epsilon^2 T_n^2(\Omega)}}$$

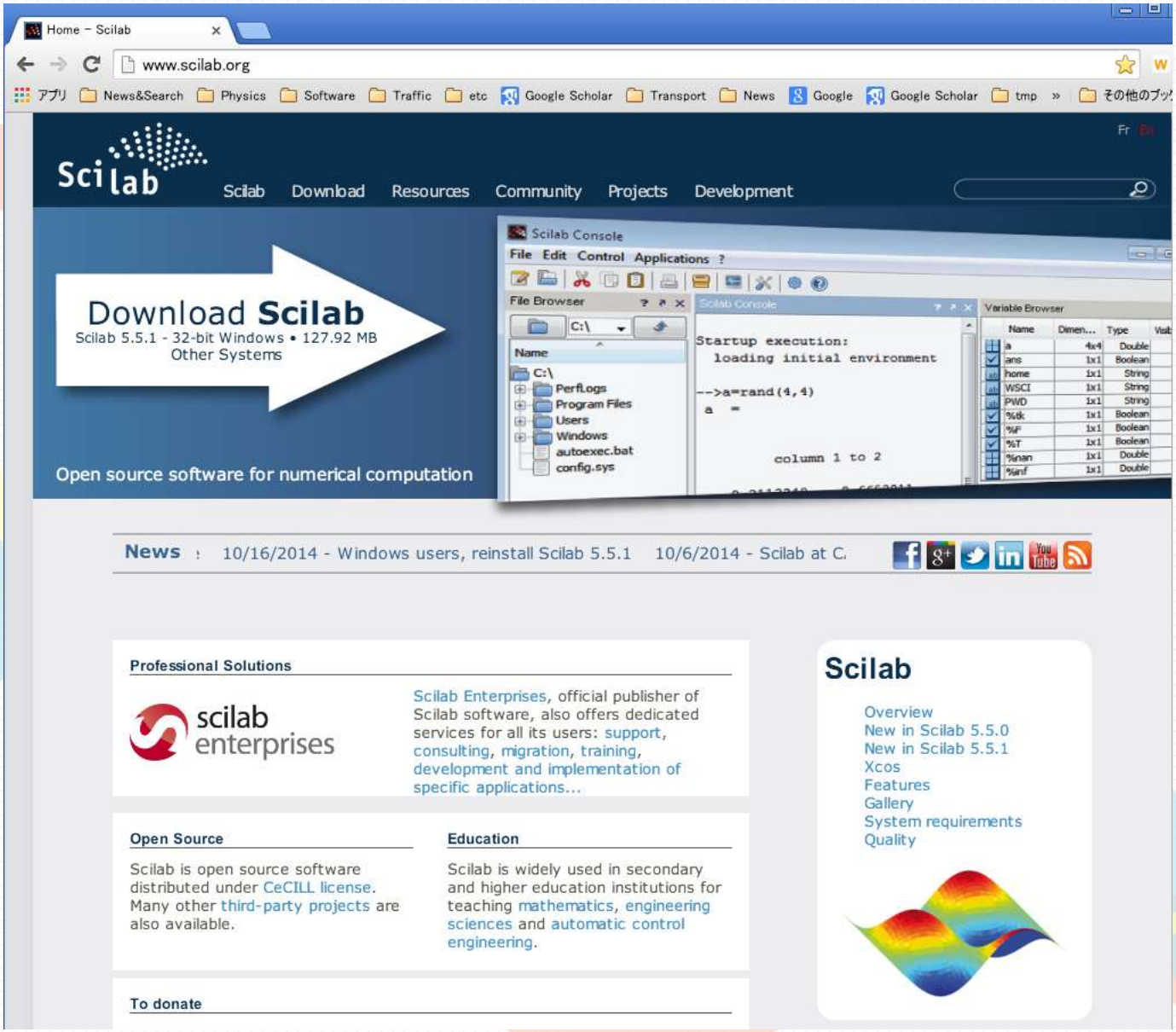
ε: Ripple coefficeint

T_n: n-th order Chebyshev polynomial





Scilab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Startup execution:
loading initial environment
-->a=rand(4,4)
column 1 to 2
Variable Browser
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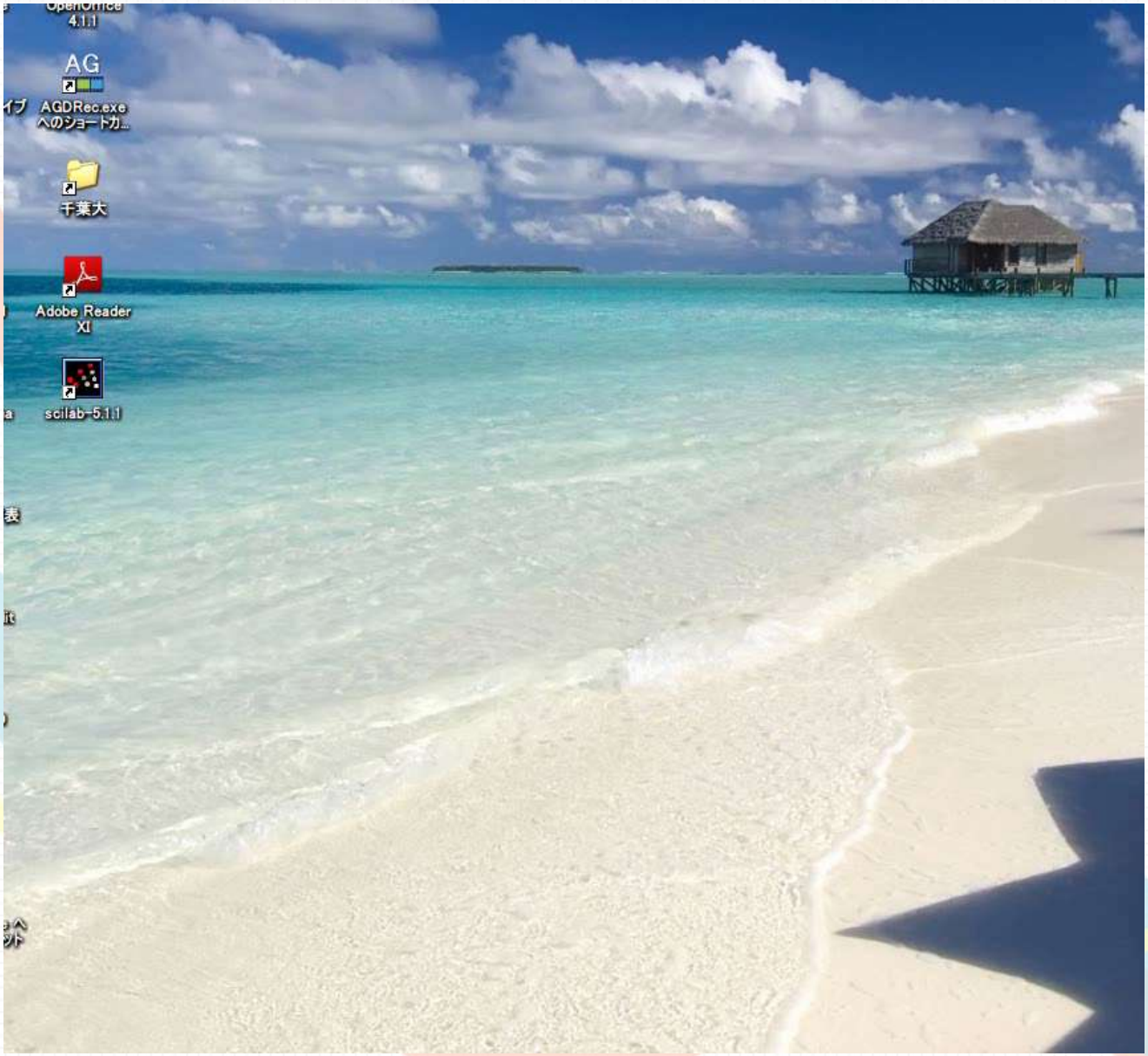
New in Scilab 5.5.1
Xcos
Features
Gallery
System requirements
Quality

Transfer function analysis with Scilab



Packaged filters

Web selection page

Mini-Circuits
Band Pass
19.2 – 23.6MHz 50Ohm