Electric Circuits for Physicists
電子回路論第10回
Figure section

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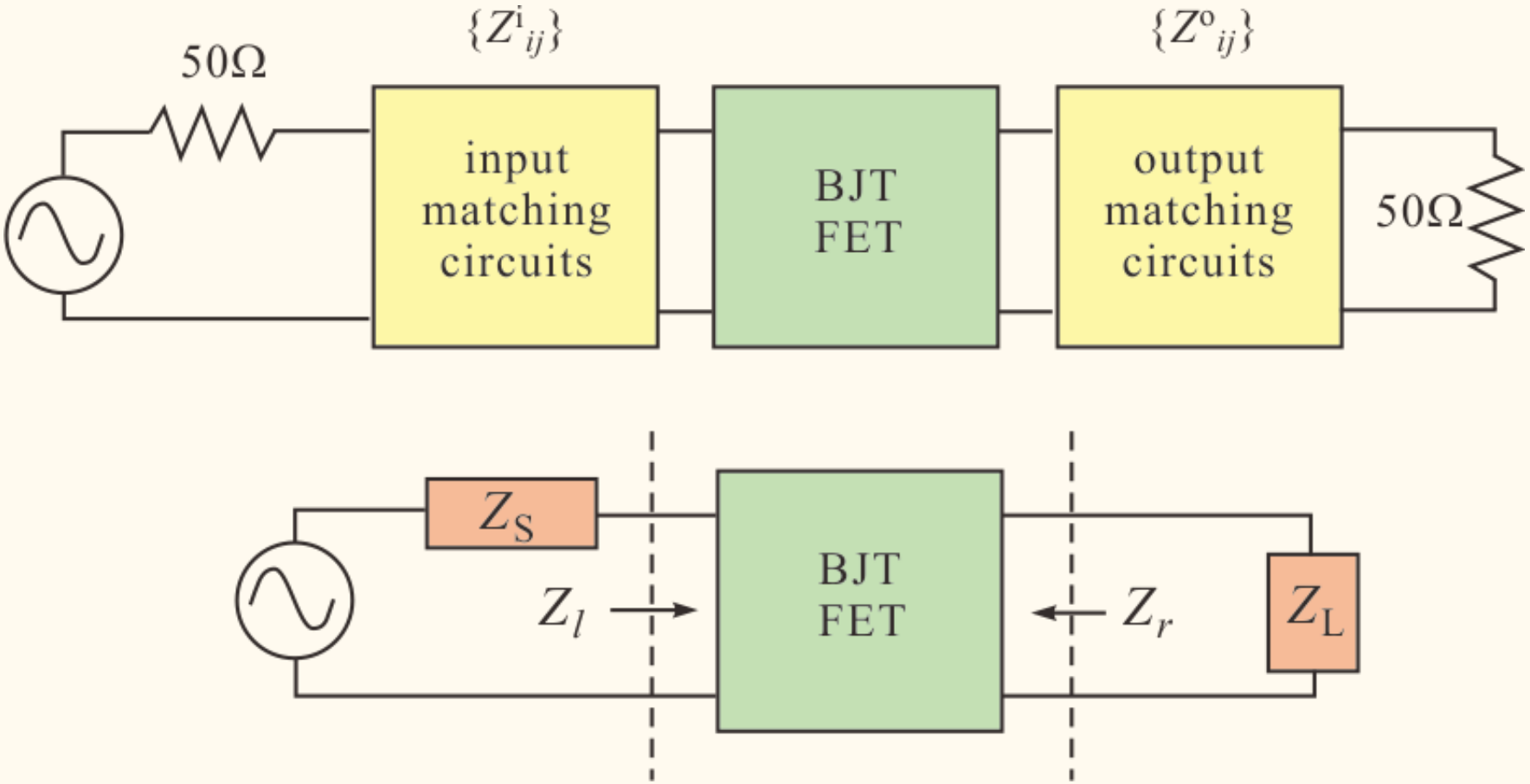
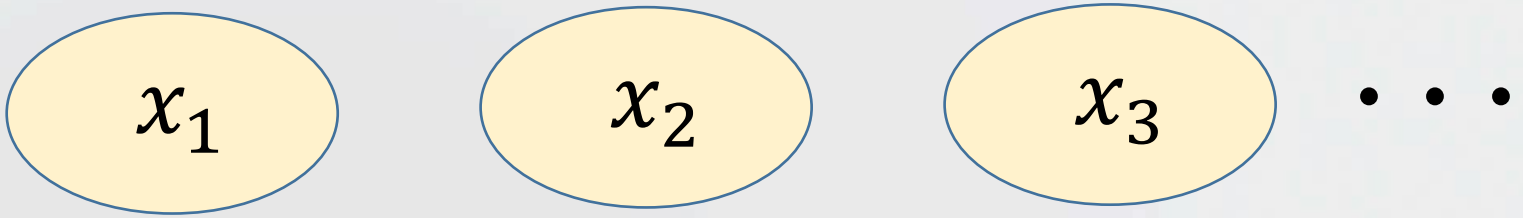
S-parameter representation of high-frequency devices



6.1 Fluctuation

Substance 1 Substance 2 Substance 3



x_j: Independent

Markovian

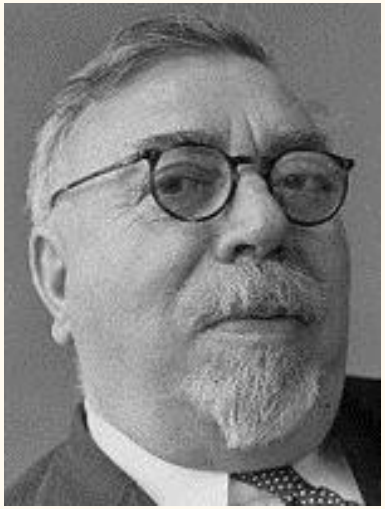
$x_1, \cdots, x_m \xrightarrow{\text{affect}} x_{m+1}$

m-th order Markovian

6.1.1 Fluctuation-Dissipation Theorem

久保亮五
Ryogo Kubo 1920-1995

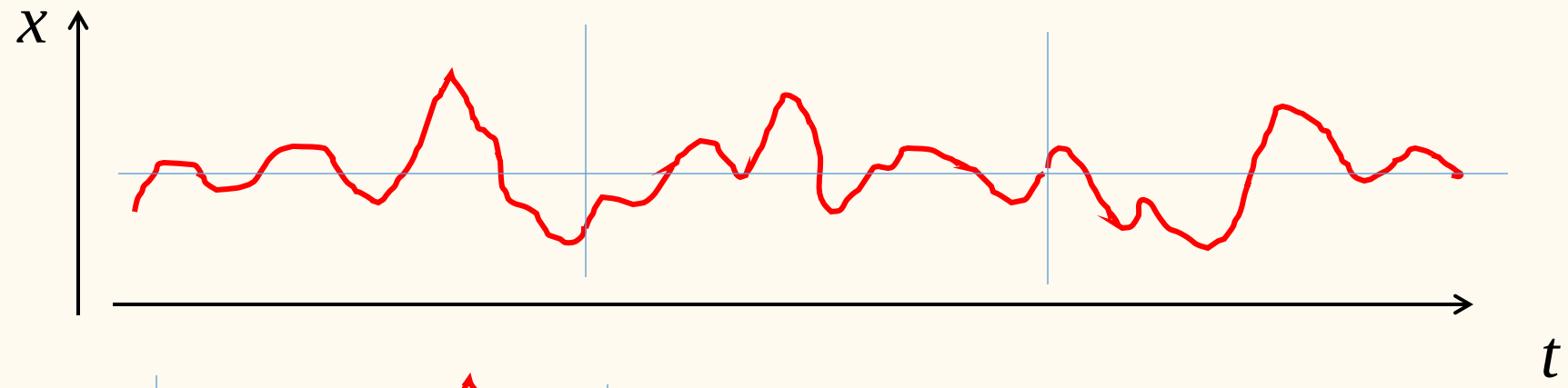
Harry Nyquist
1889-1976

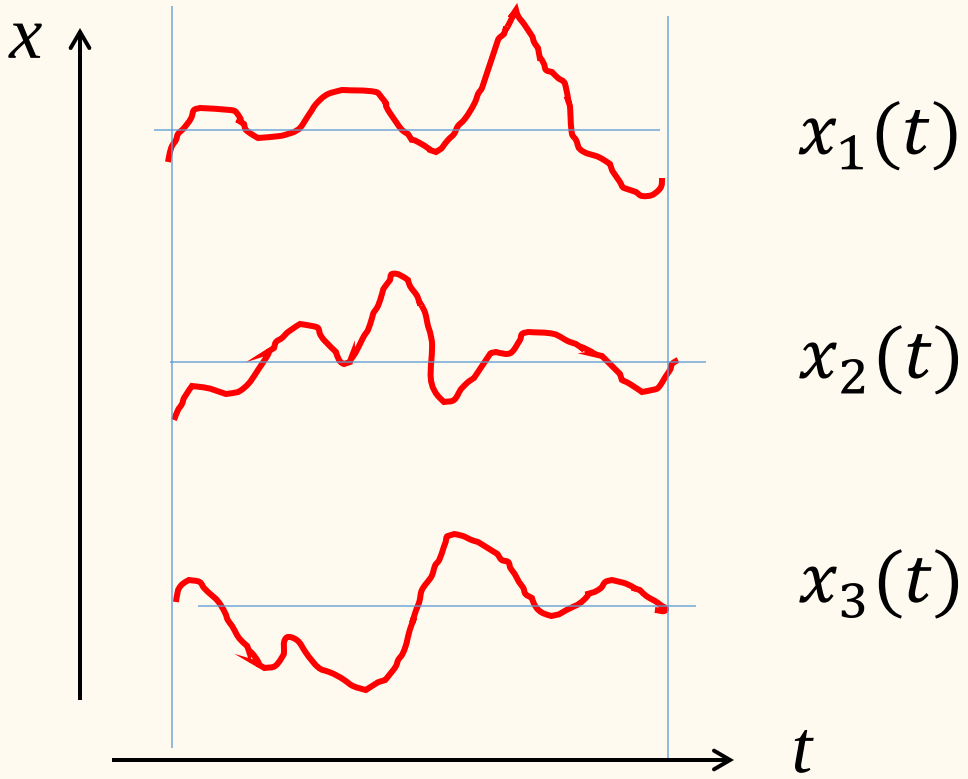


Nobert Wiener
1894-1964

Aleksandr Khinchin
1894-1959

Random process to distribution



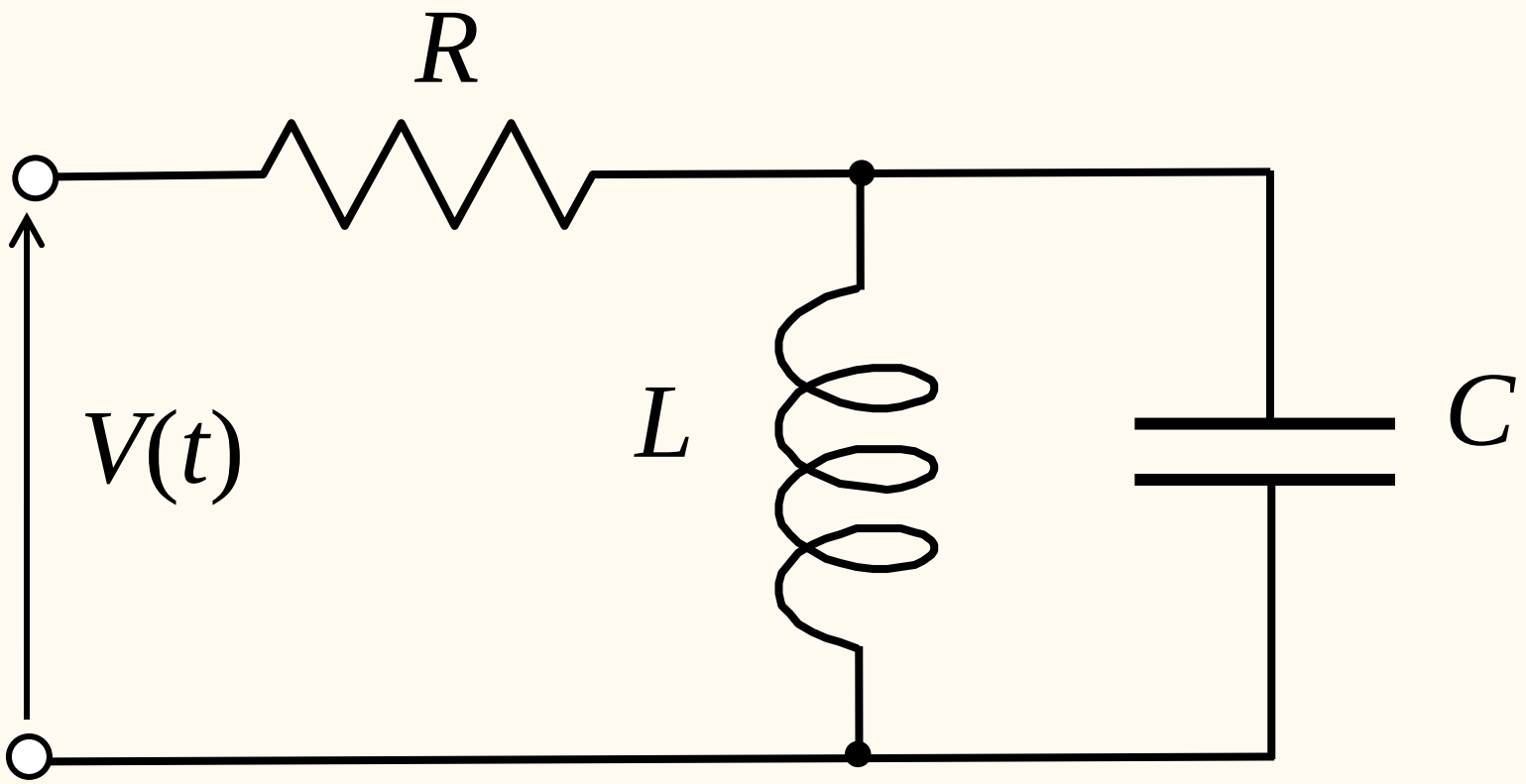


$x_1(t)$

$x_2(t)$

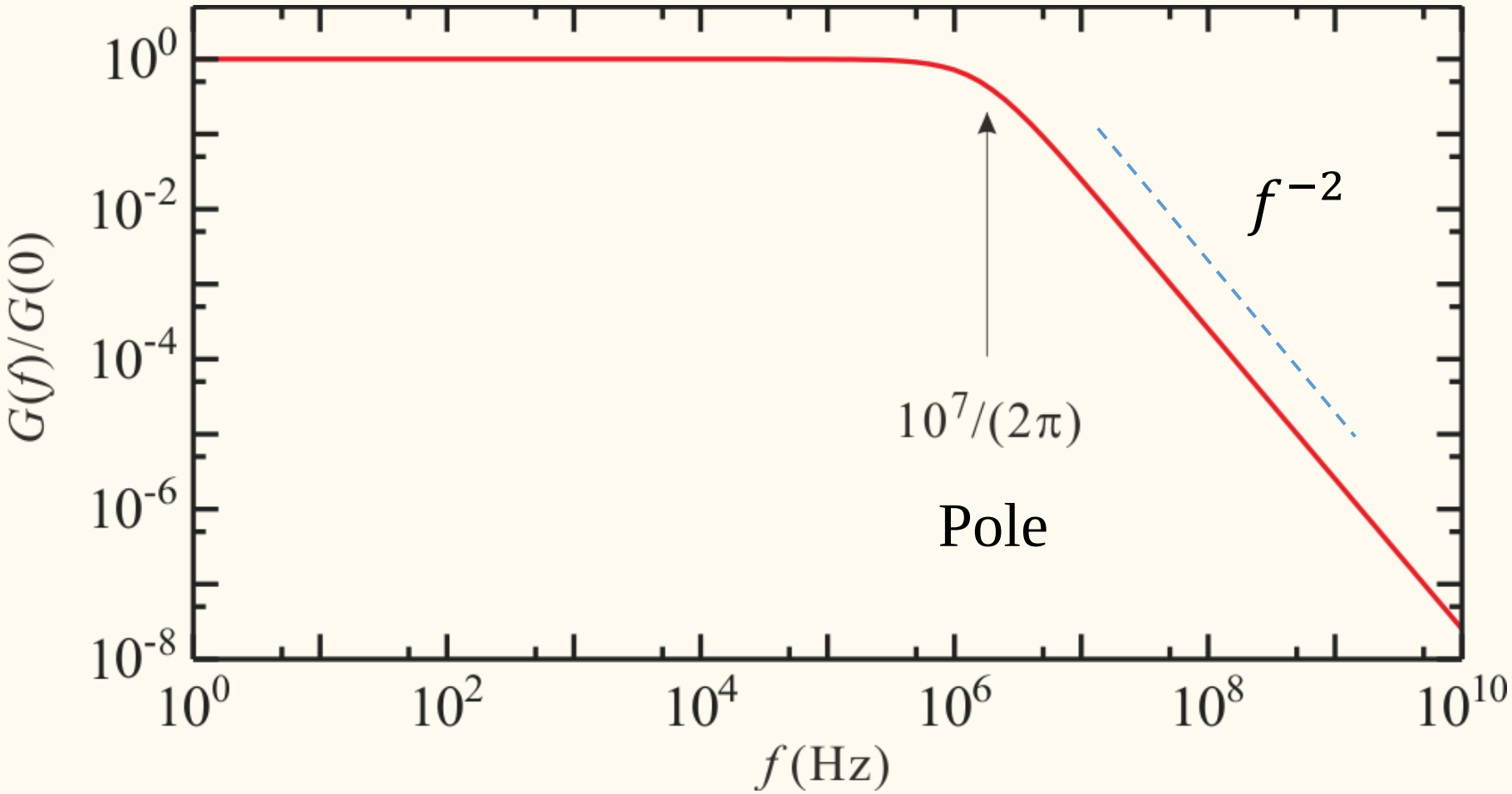
$x_3(t)$

6.1.1 Fluctuation-Dissipation Theorem

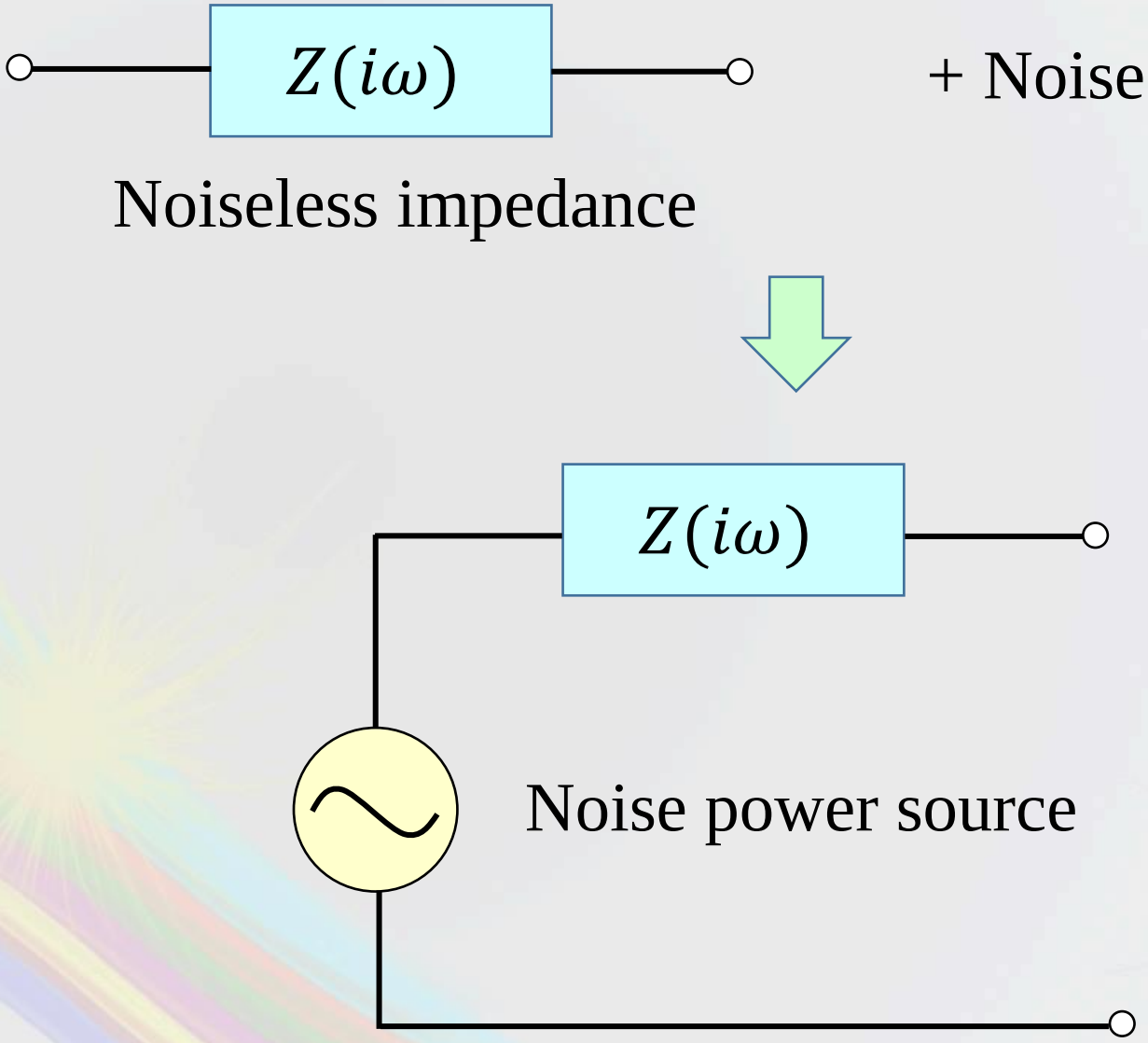


6.1.2 Wiener-Khintchine Theorem

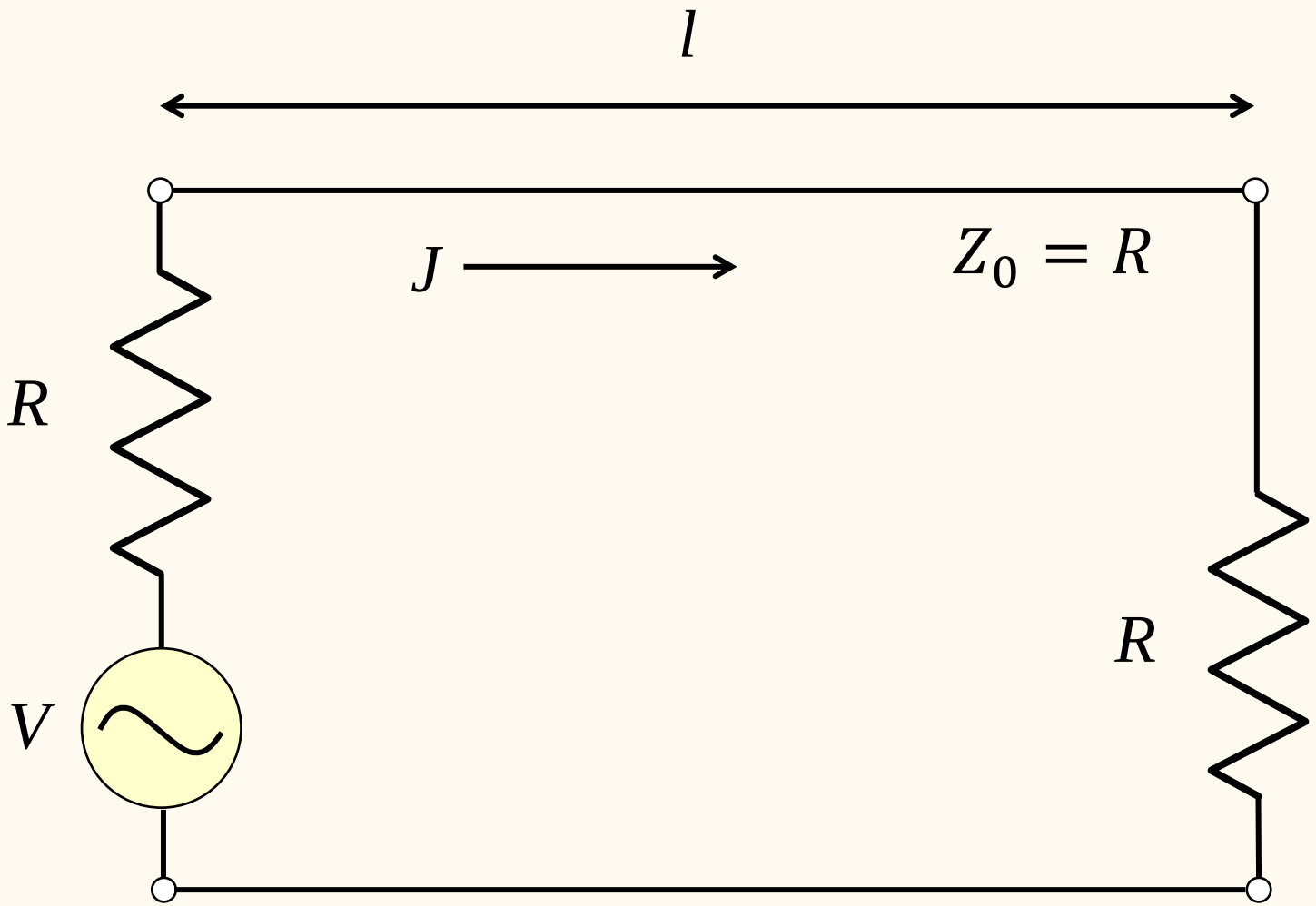
$\tau_0 = 10^{-7}\text{s}$ (10MHz)



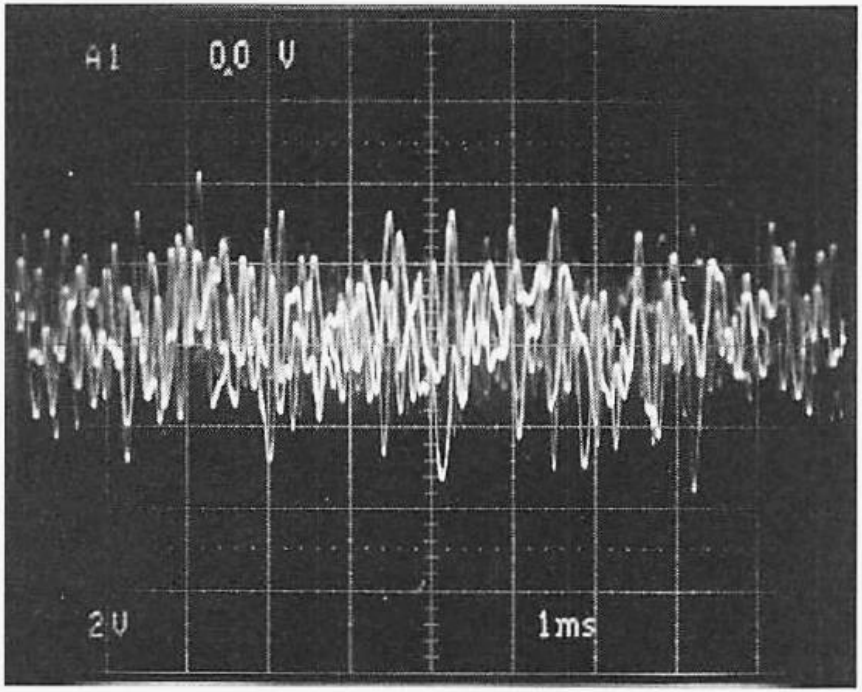
6.1.3 Electric circuit treatment of noise



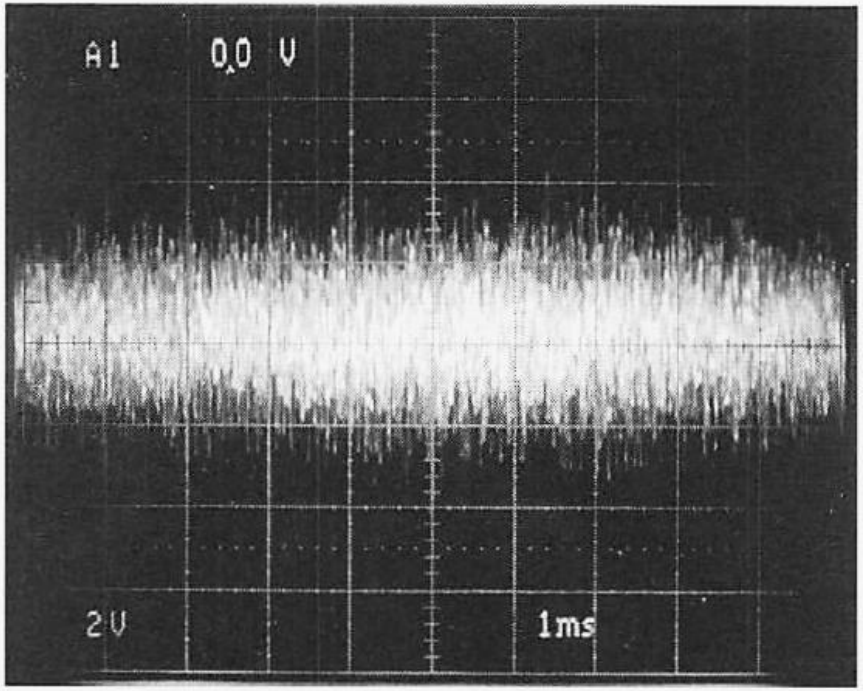
6.1.4 Nyquist Theorem



Thermal noise



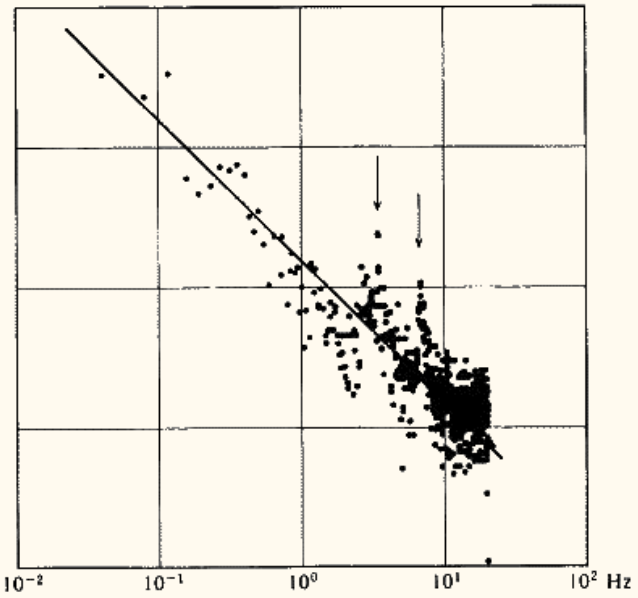
(a) 上限周波数5 kHz (−3dB) 1 V_{rms}の熱雑音を1 ms/divで観測



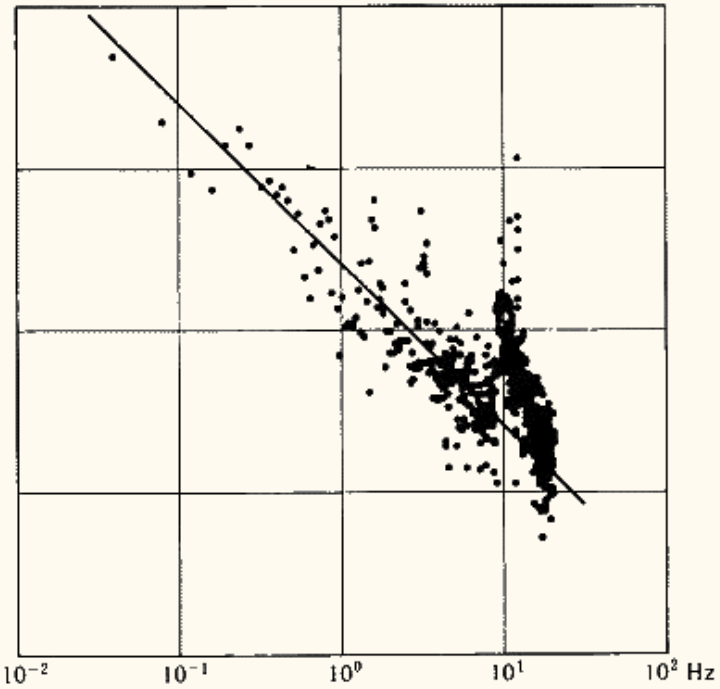
(b) 上限周波数100 kHz (−3dB)1 V_{rms}の熱雑音を1 ms/divで観測

〈写真 1-1〉 熱雑音の測定

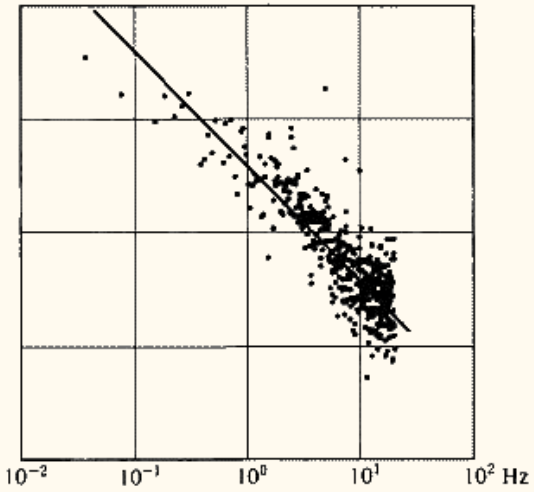
6.1.6 1/f noise



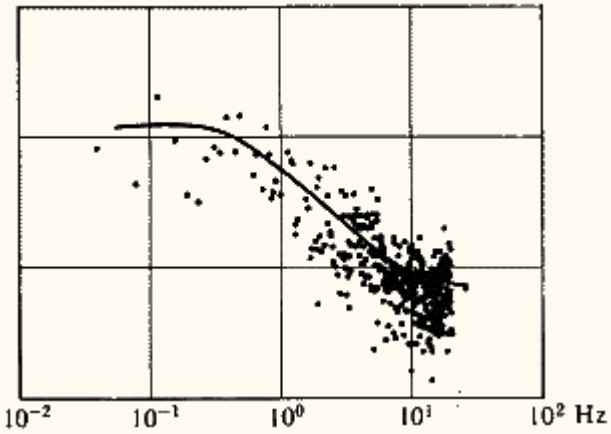
J. S. Bach, Brandenburg Concerto No.1



A. Vivaldi, Four Seasons, Spring

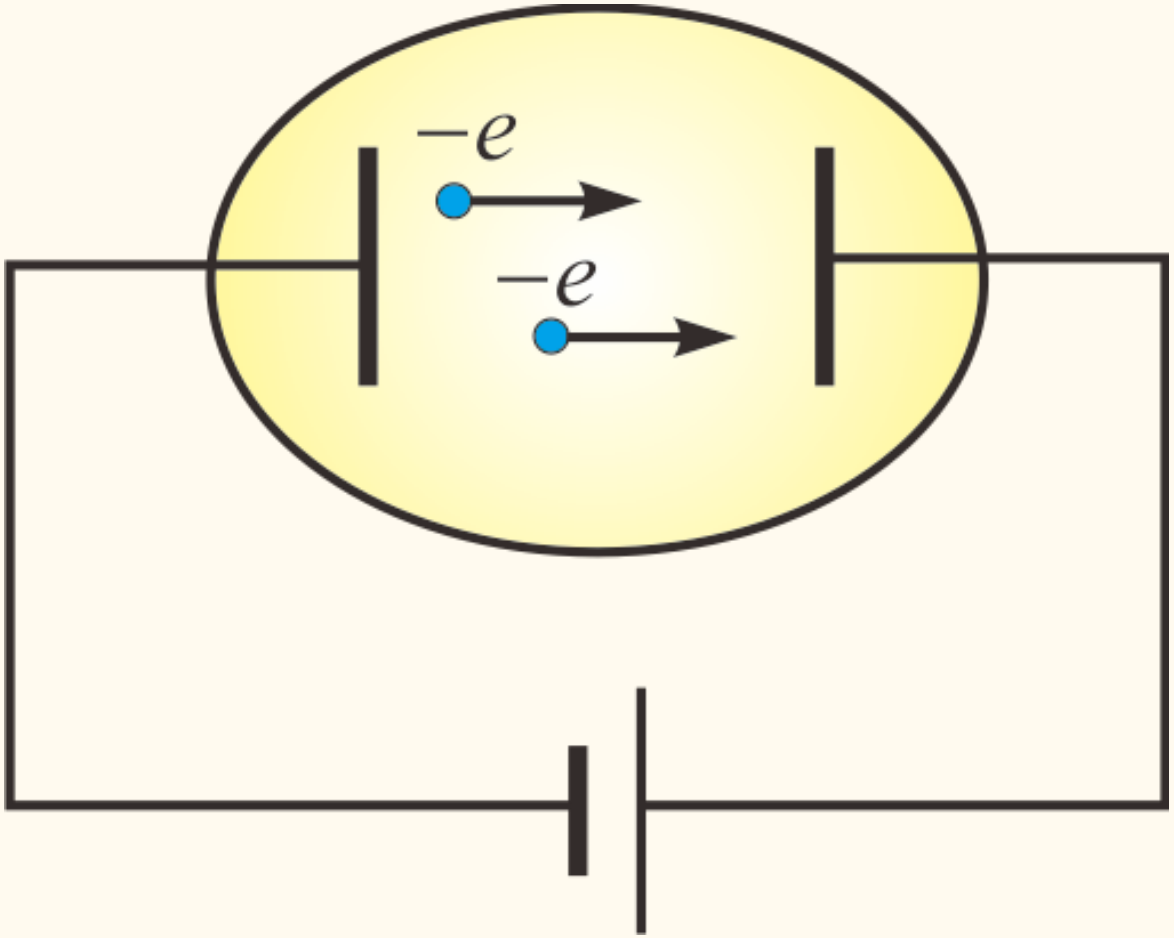


Kawai Naoko, Smile for me

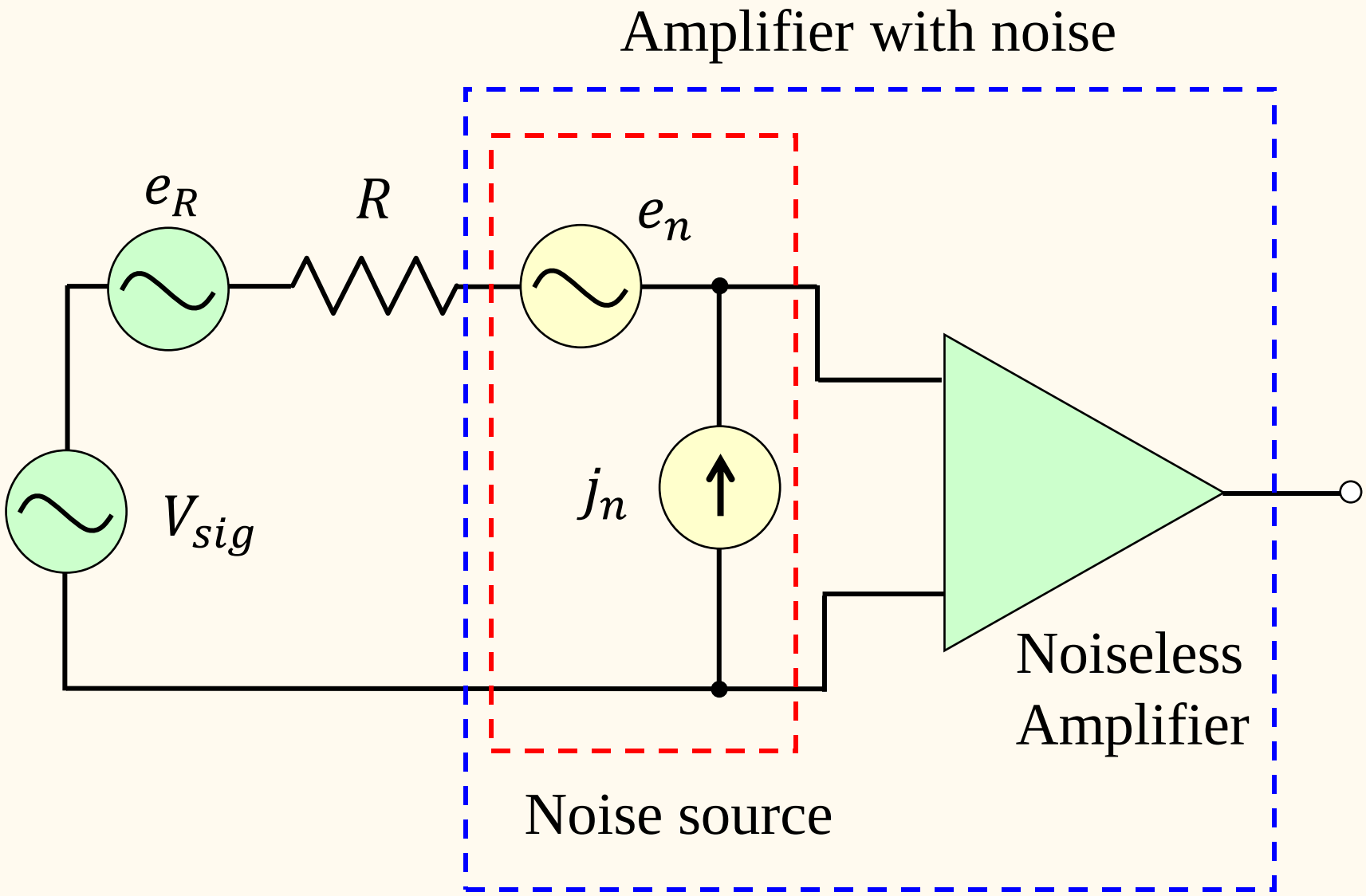


S. Sato, Keshin (incarnation) II

6.1.5 Shot Noise



6.2 Noises from Amplifiers



6.2.2 Noise impedance matching