

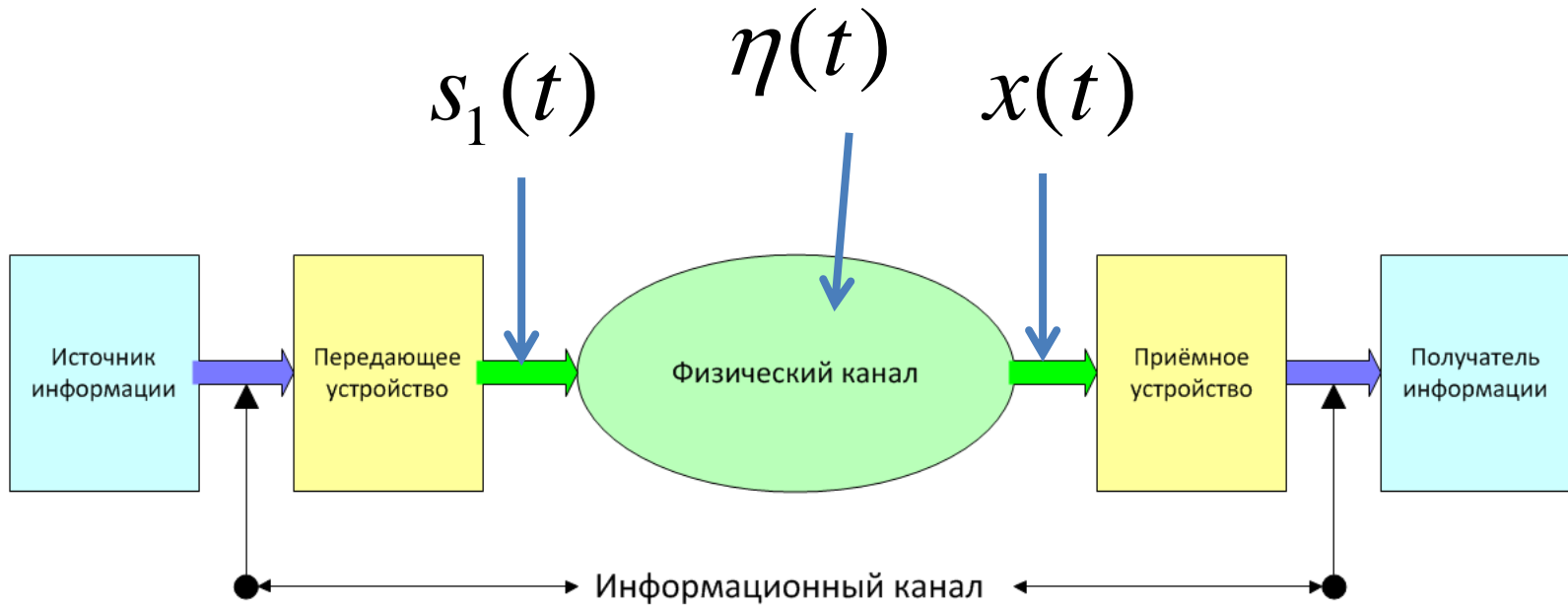
СПбГУТ им. проф. М.А. Бонч-Бруевича

***Основы
инфокоммуникационных
систем***

2016 г.

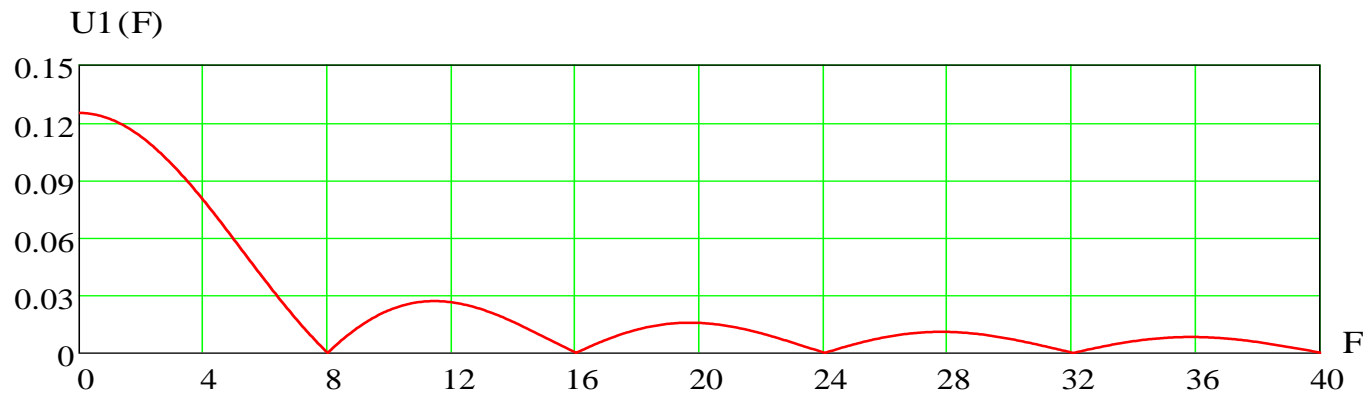
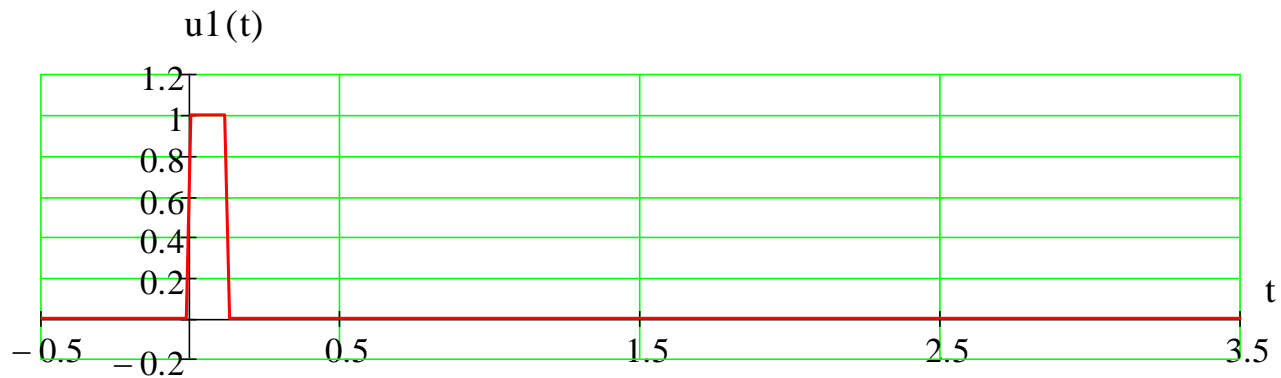
Передача цифровых сигналов

Основные понятия

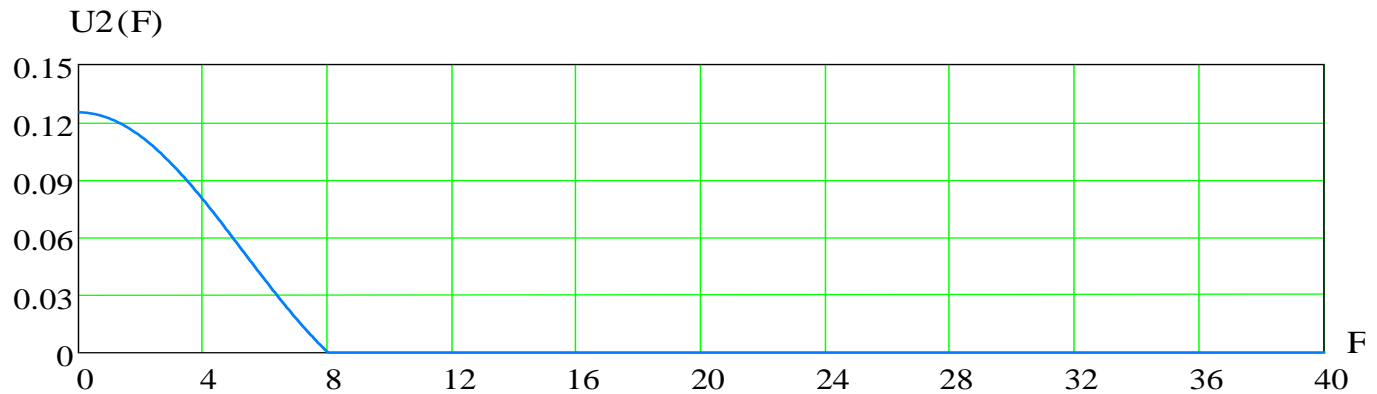
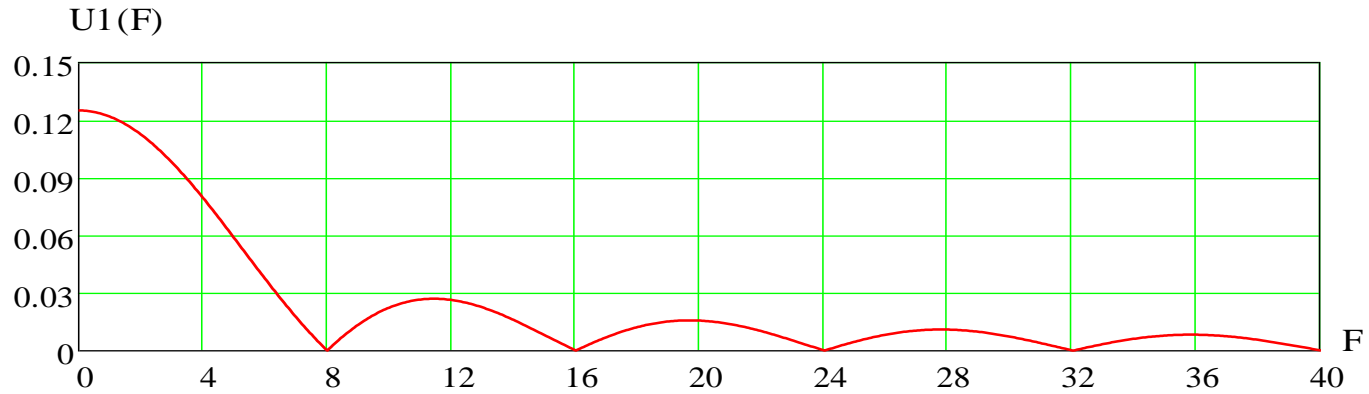


$$x(t) = s_2(t) + \eta(t)$$

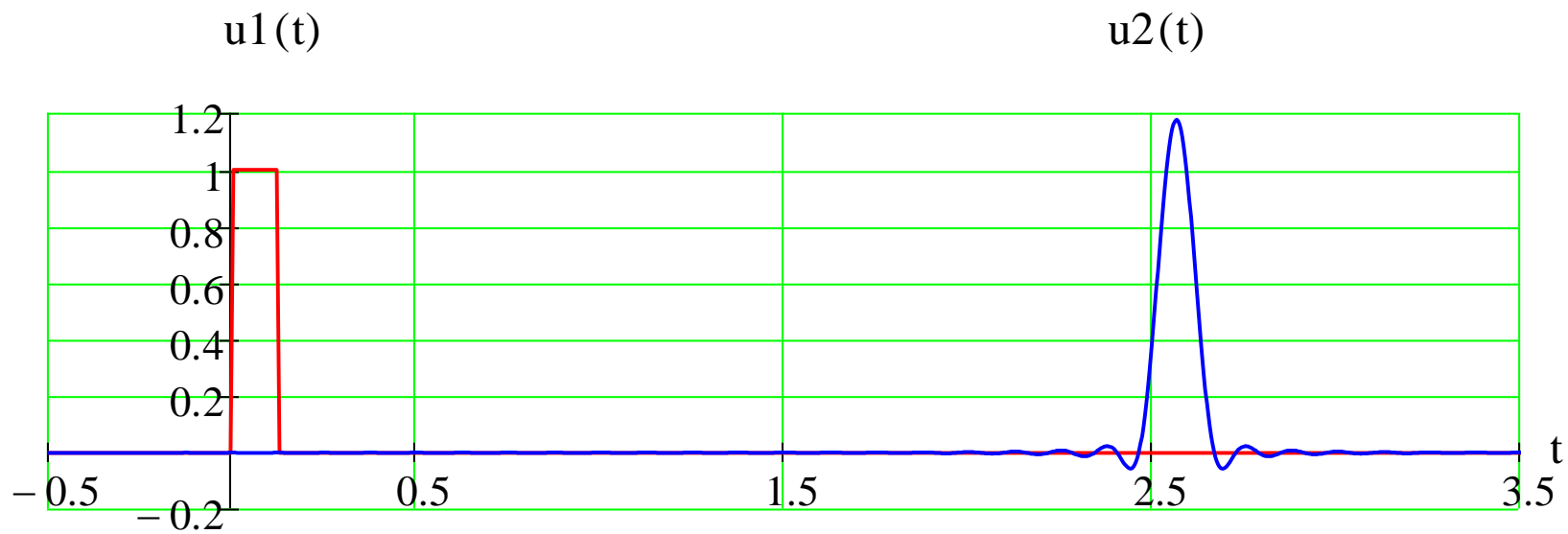
Преобразование сигнала в канале связи



Преобразование сигнала в канале связи

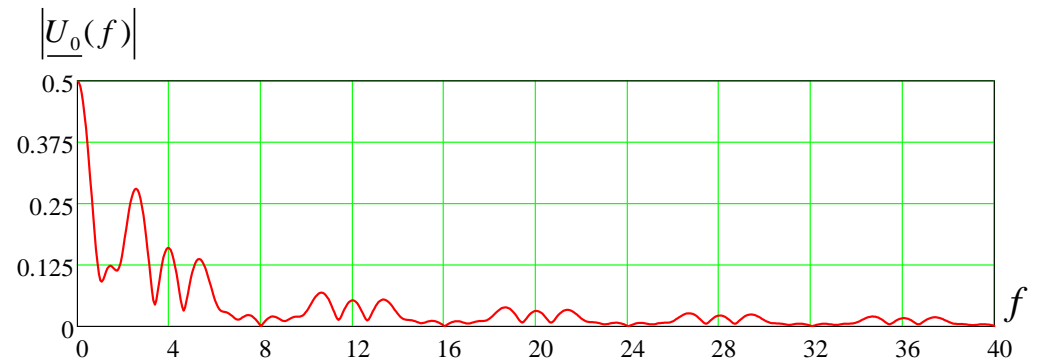
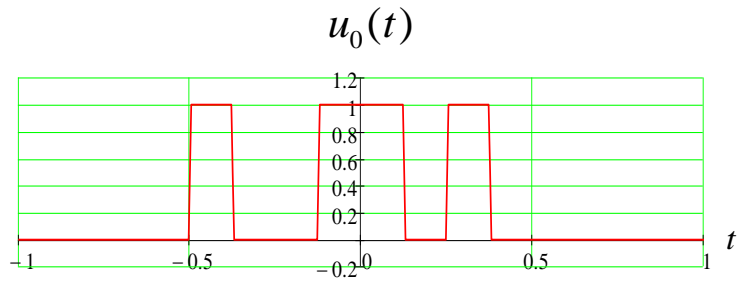


Преобразование сигнала в канале связи

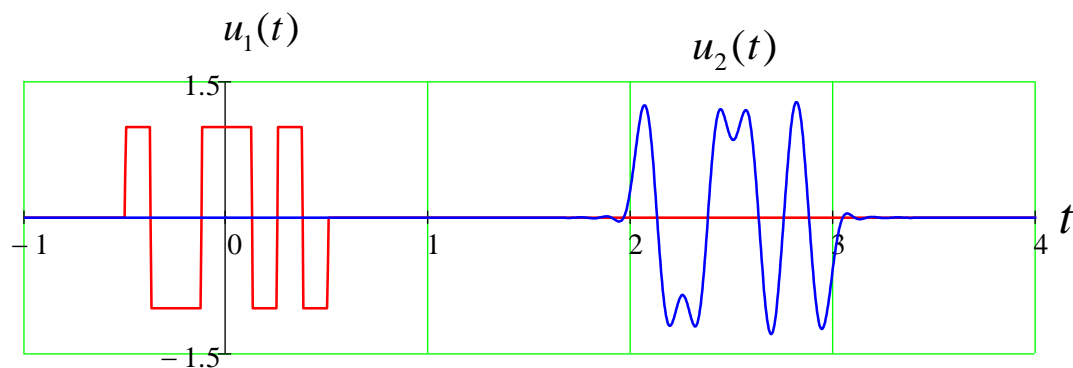
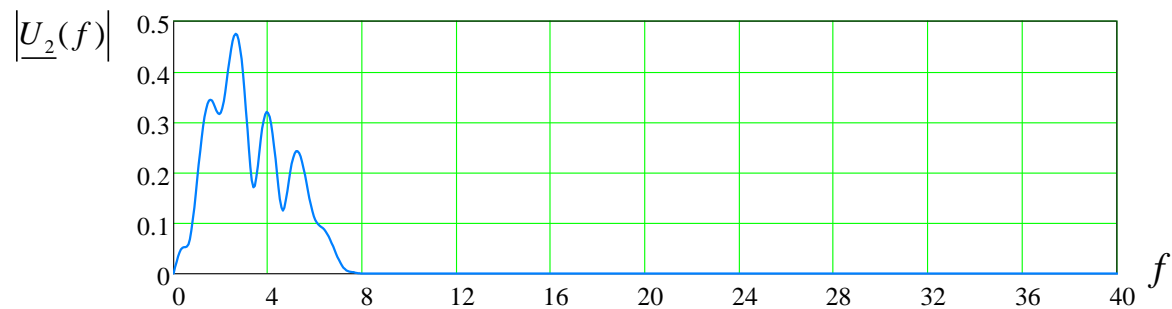
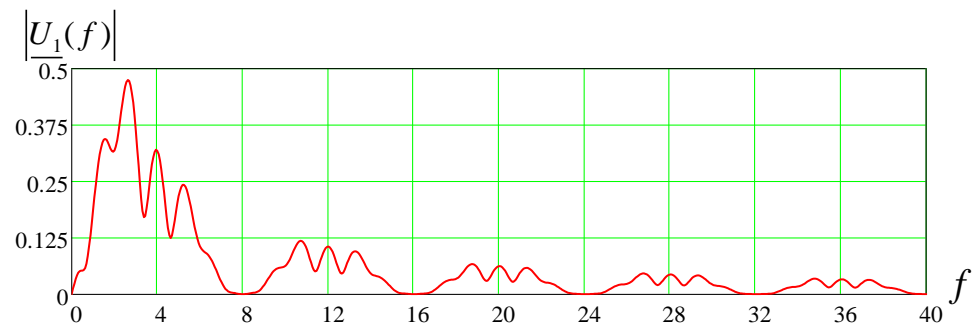
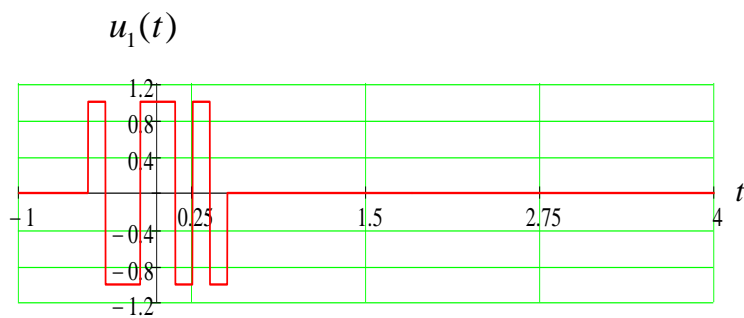


$$W_2 = 0,9 \cdot W_1;$$

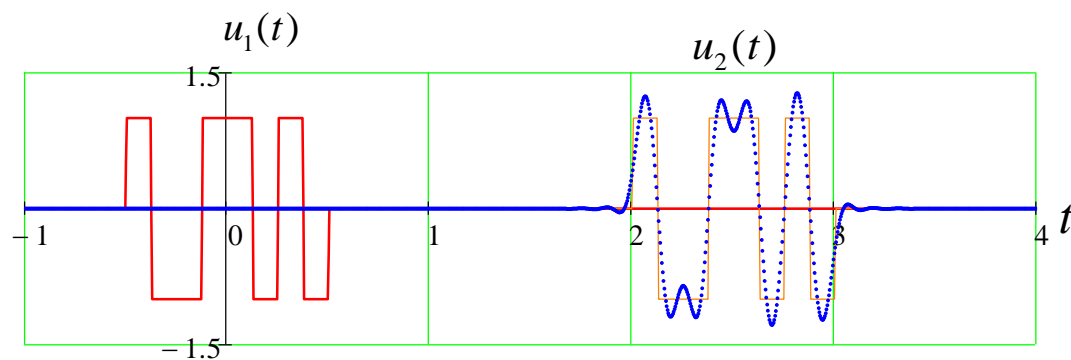
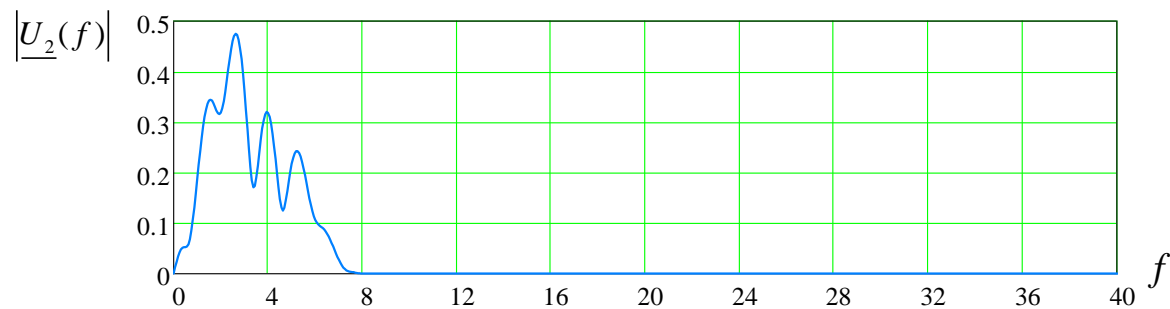
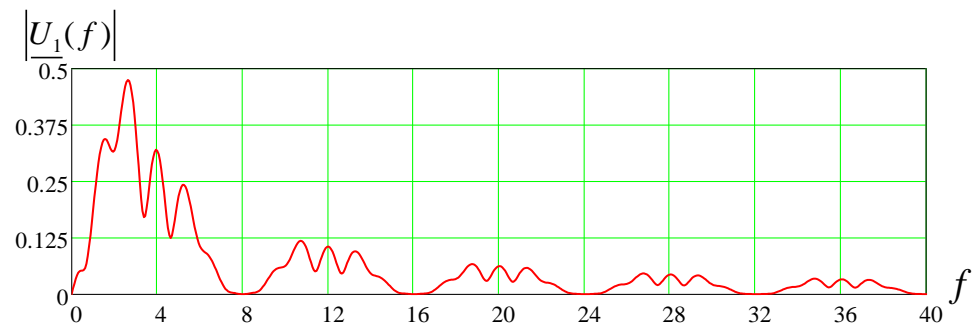
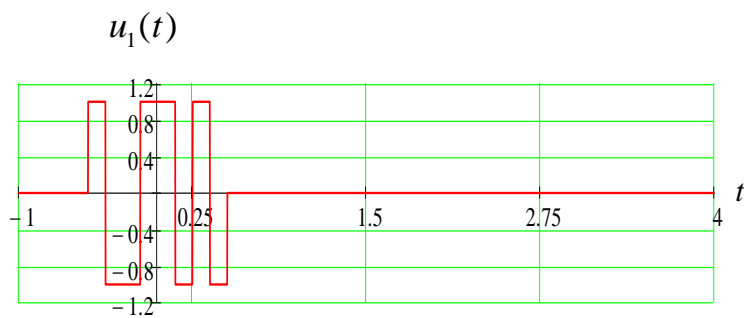
Преобразование сигнала в канале связи



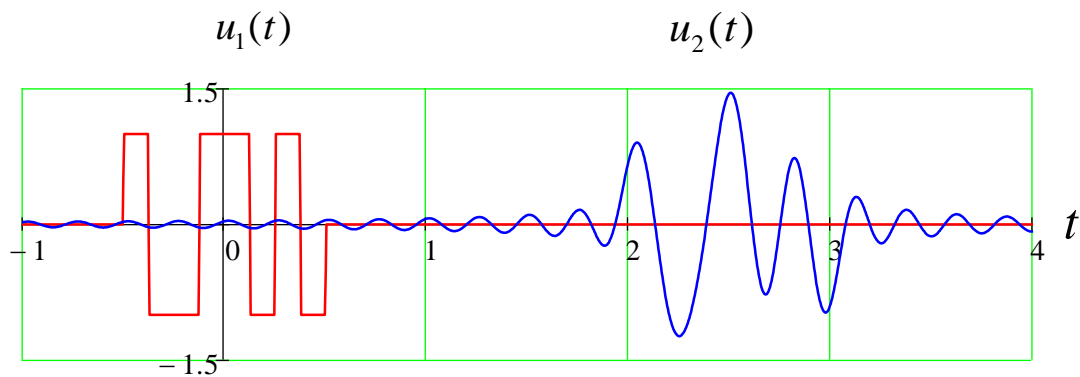
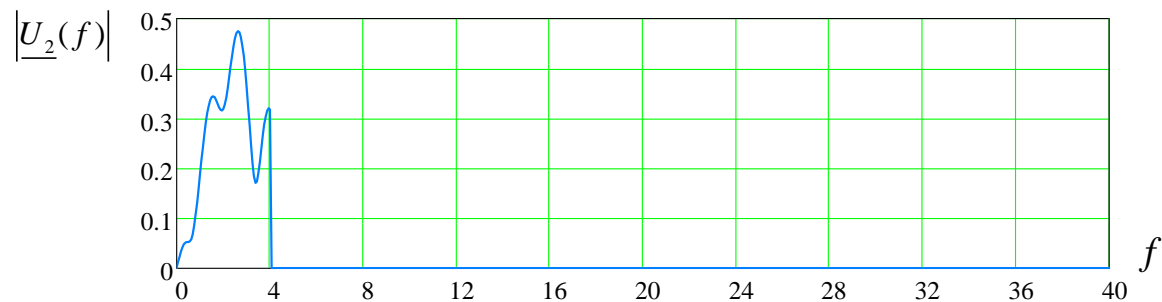
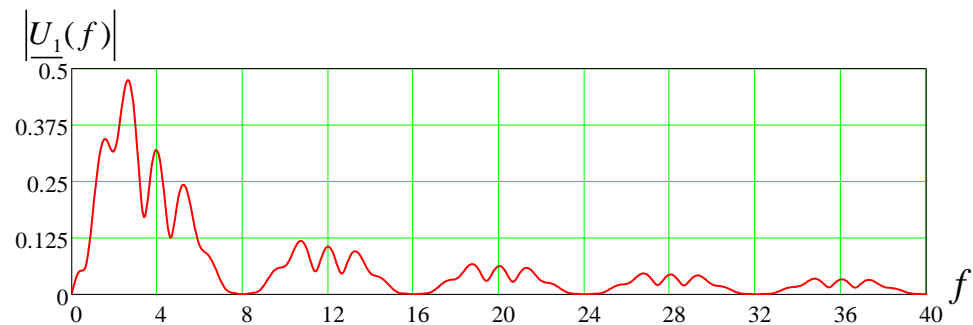
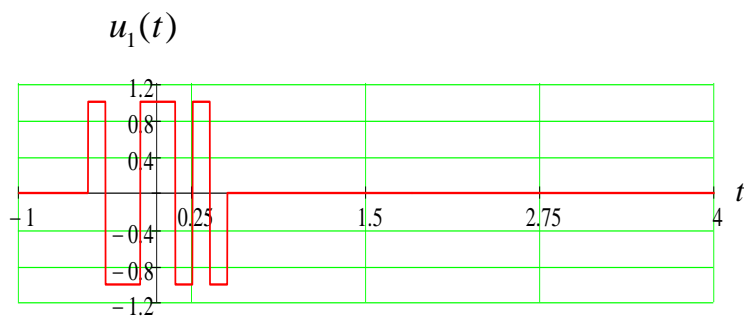
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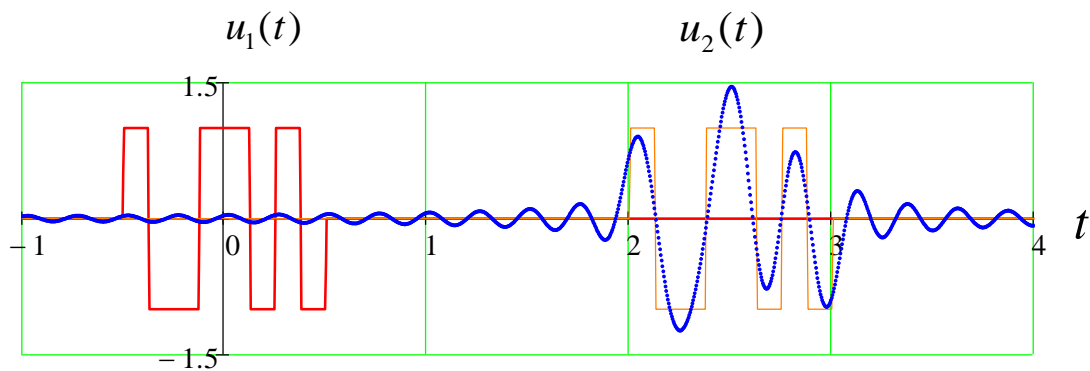
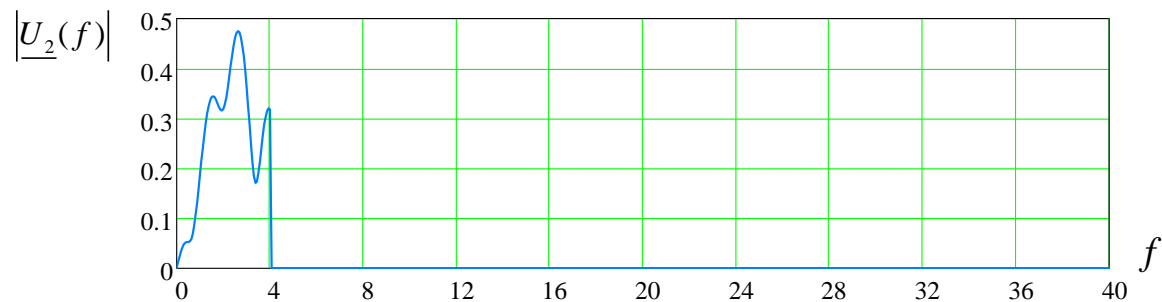
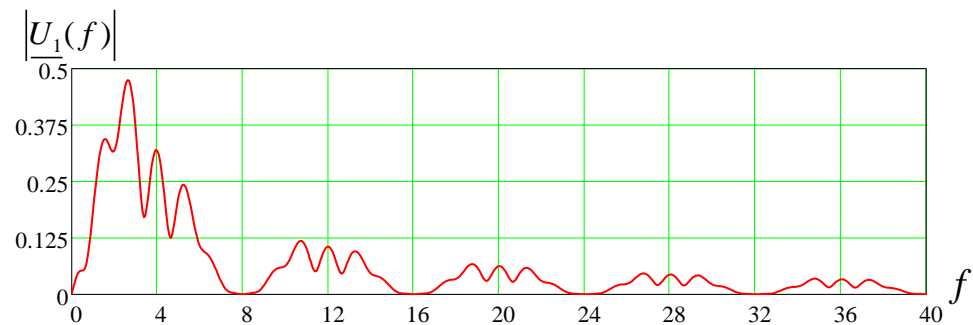
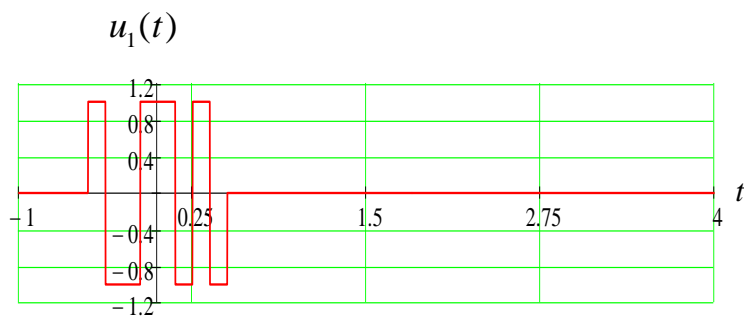
Преобразование сигнала в канале связи



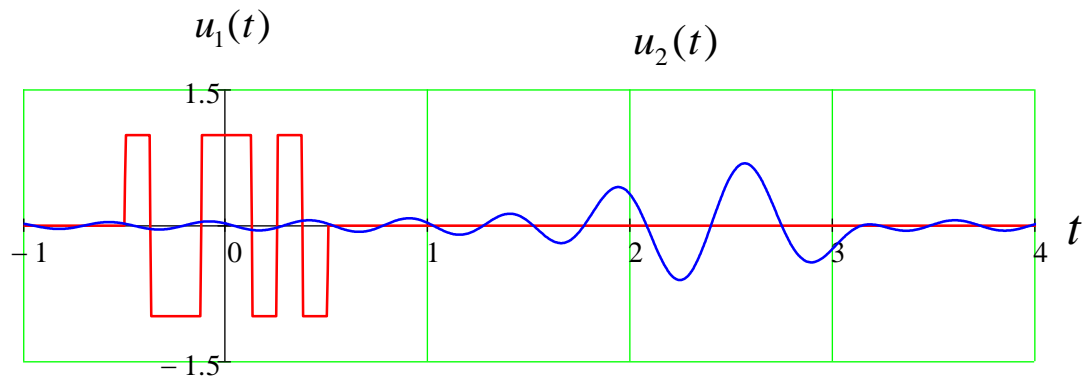
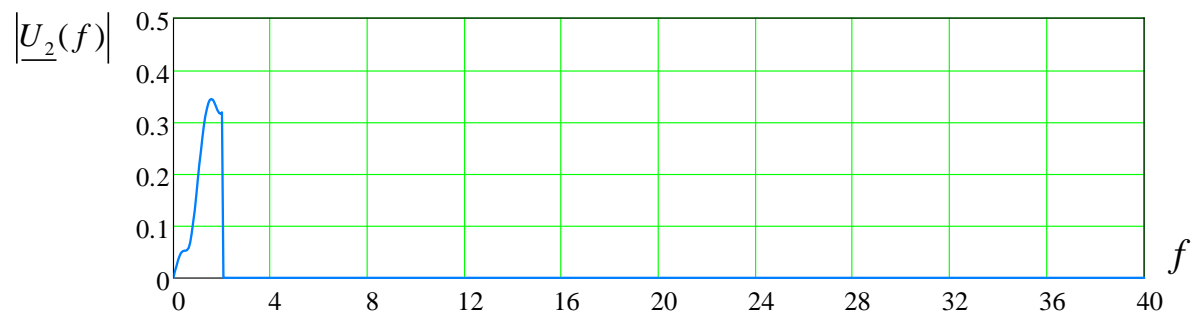
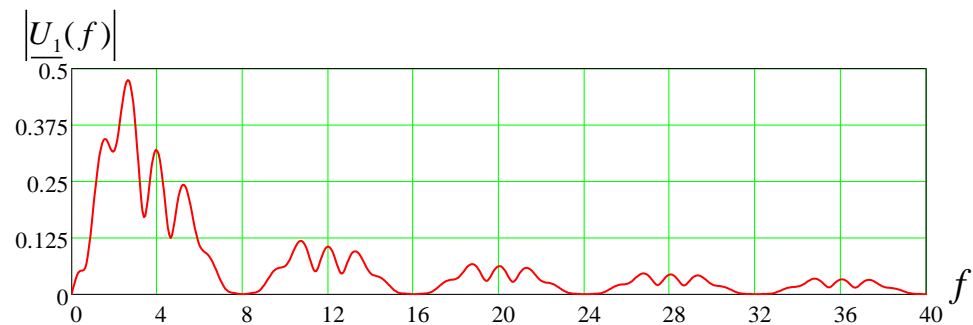
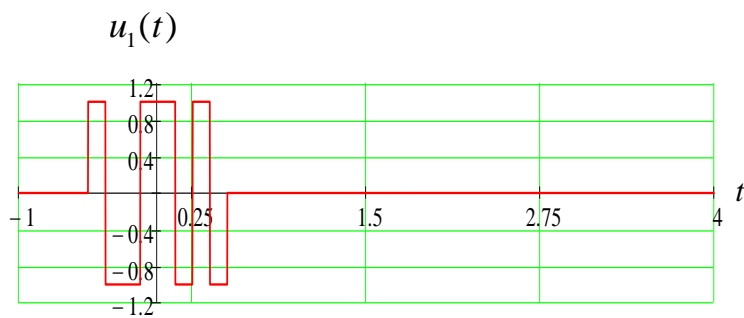
Преобразование сигнала в канале связи



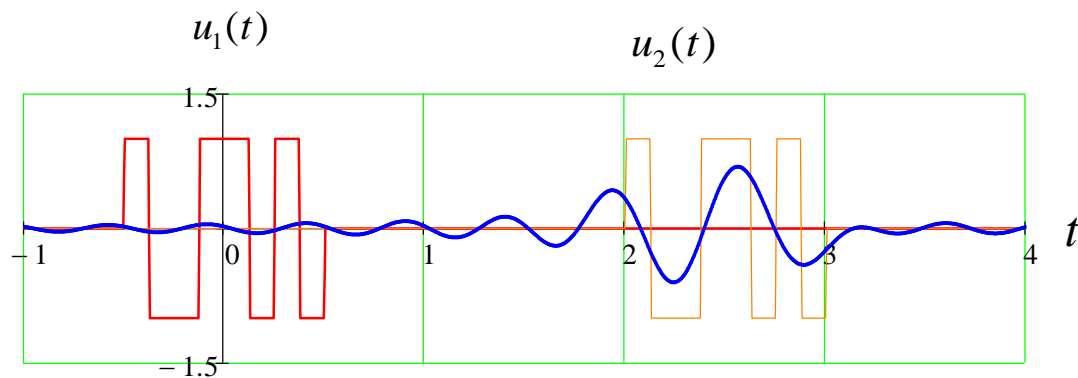
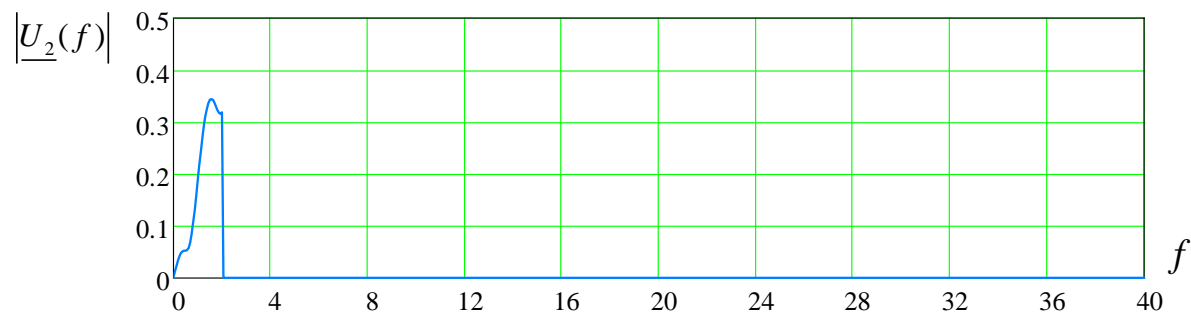
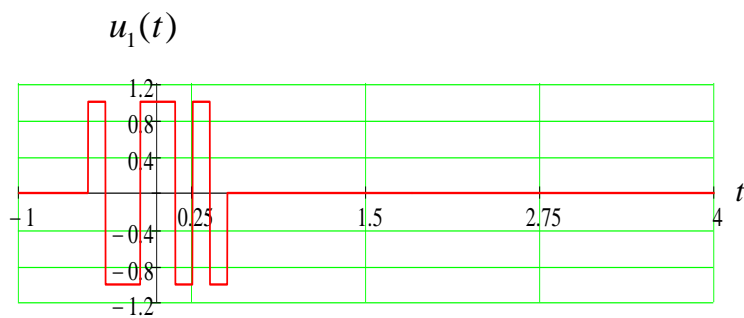
Преобразование сигнала в канале связи



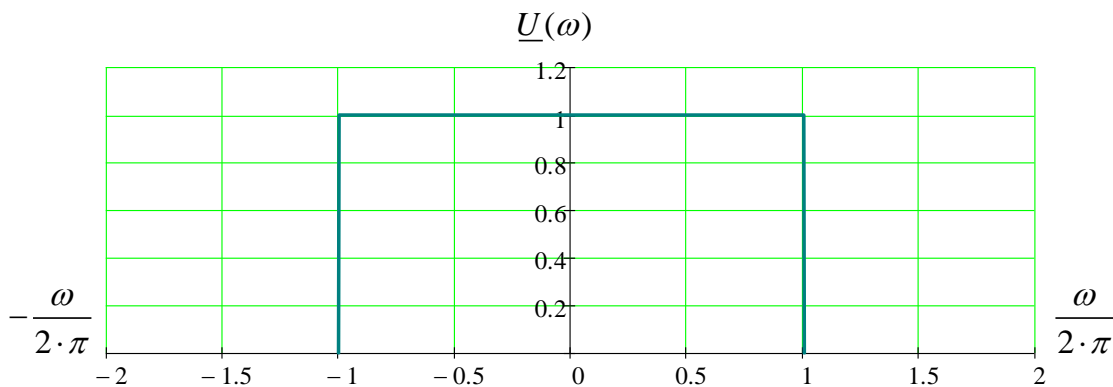
Преобразование сигнала в канале связи



Преобразование сигнала в канале связи



Преобразование сигнала в канале связи

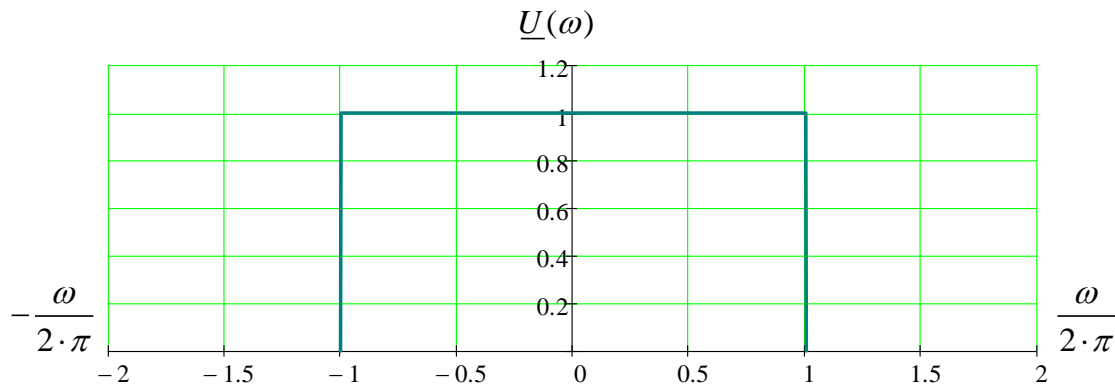


$$u(t) = \frac{1}{2 \cdot \pi} \cdot \int_{-\infty}^{\infty} \underline{U}(\omega) \cdot e^{j \cdot \omega \cdot t} \cdot \partial \omega;$$

$$\operatorname{Re}[\underline{U}(\omega)] = 1, \quad \text{при } \left| \frac{\omega}{2 \cdot \pi} \right| \leq 1;$$

$$\operatorname{Im}[\underline{U}(\omega)] = 0$$

Преобразование сигнала в канале связи



$$u(t) = \frac{1}{2 \cdot \pi} \cdot \int_{-\infty}^{\infty} \underline{U}(\omega) \cdot e^{j \cdot \omega \cdot t} \cdot \partial \omega;$$

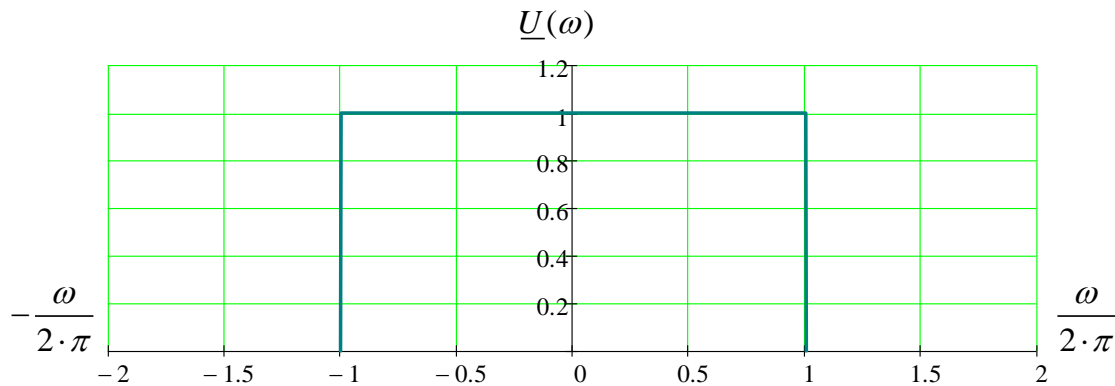
$$\operatorname{Re}[\underline{U}(\omega)] = 1, \quad \text{при } \left| \frac{\omega}{2 \cdot \pi} \right| \leq 1;$$

$$\operatorname{Im}[\underline{U}(\omega)] = 0$$

$$u(t) = \frac{1}{\pi} \cdot \int_0^{2 \cdot \pi} 1 \cdot \cos(\omega \cdot t) \cdot \partial \omega;$$

$$u(t) = \frac{1}{\pi} \cdot \left. \frac{\sin(\omega \cdot t)}{t} \right|_0^{2 \cdot \pi};$$

Преобразование сигнала в канале связи

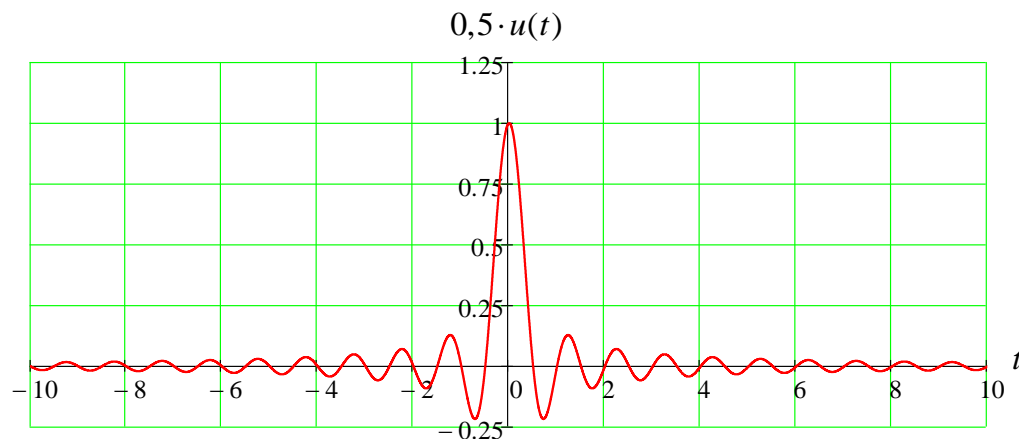


$$u(t) = \frac{1}{2 \cdot \pi} \cdot \int_{-\infty}^{\infty} \underline{U}(\omega) \cdot e^{j \cdot \omega \cdot t} \cdot \partial \omega;$$

$$\operatorname{Re}[\underline{U}(\omega)] = 1, \quad \text{при } \left| \frac{\omega}{2 \cdot \pi} \right| \leq 1;$$

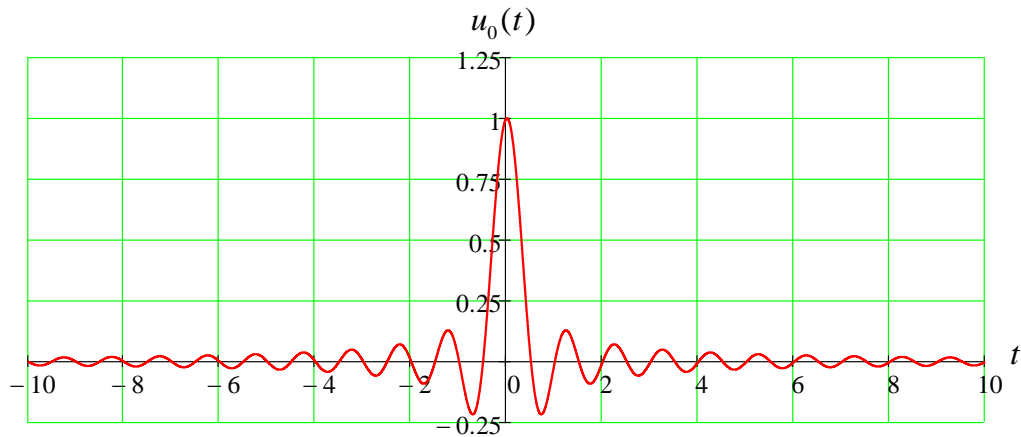
$$\operatorname{Im}[\underline{U}(\omega)] = 0$$

$$u(t) = \frac{1}{\pi} \cdot \int_0^{2 \cdot \pi} 1 \cdot \cos(\omega \cdot t) \cdot \partial \omega; \quad u(t) = \frac{1}{\pi} \cdot \left. \frac{\sin(\omega \cdot t)}{t} \right|_0^{2 \cdot \pi};$$



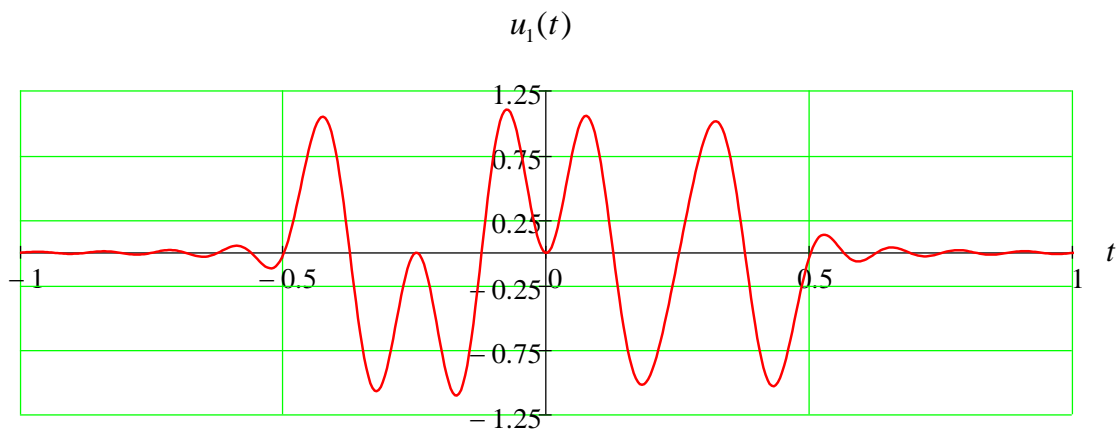
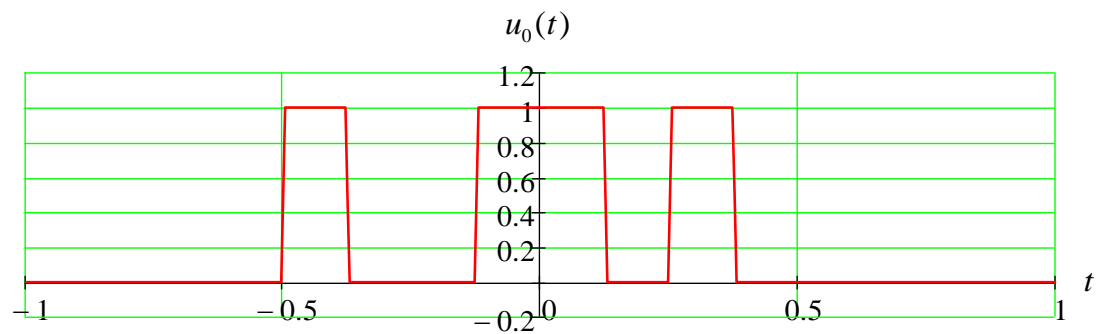
$$u(t) = 2 \cdot \frac{\sin(2 \cdot \pi \cdot t)}{2 \cdot \pi \cdot t};$$

Преобразование сигнала в канале связи

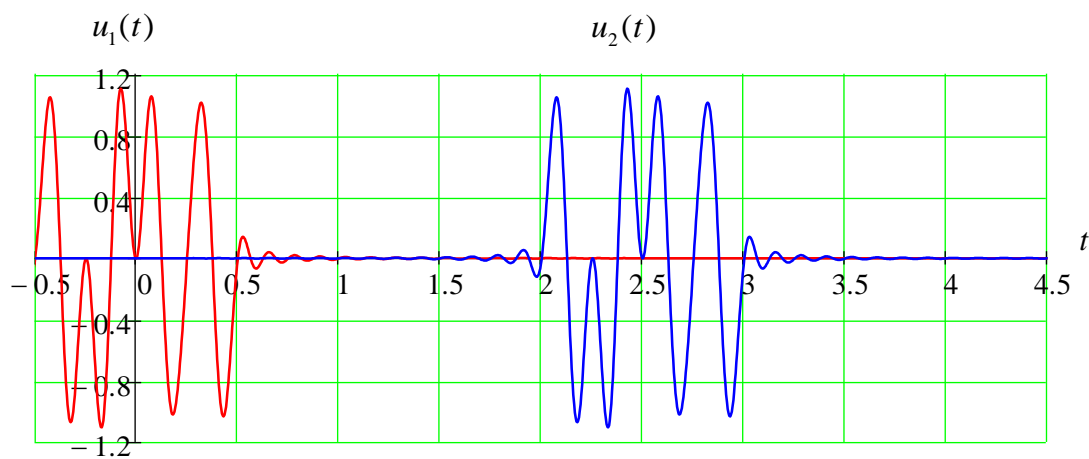
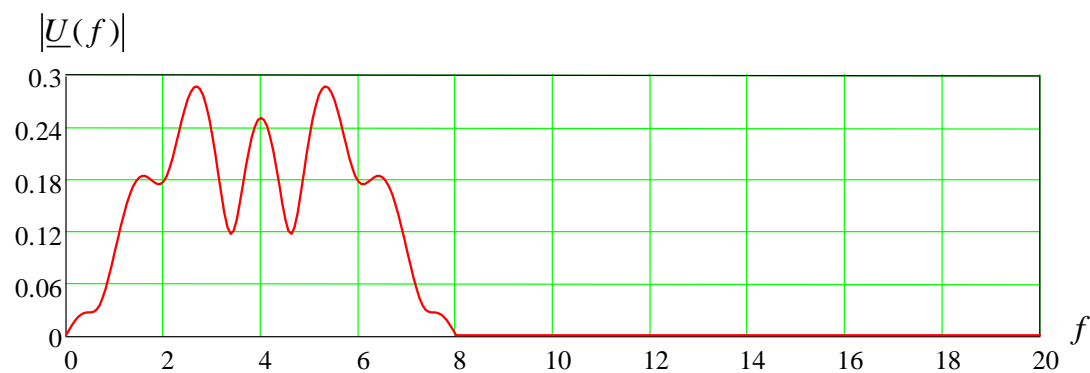


$$u_0(t) = 2 \cdot \frac{\sin(2 \cdot \pi \cdot t)}{2 \cdot \pi \cdot t};$$

Преобразование сигнала в канале связи

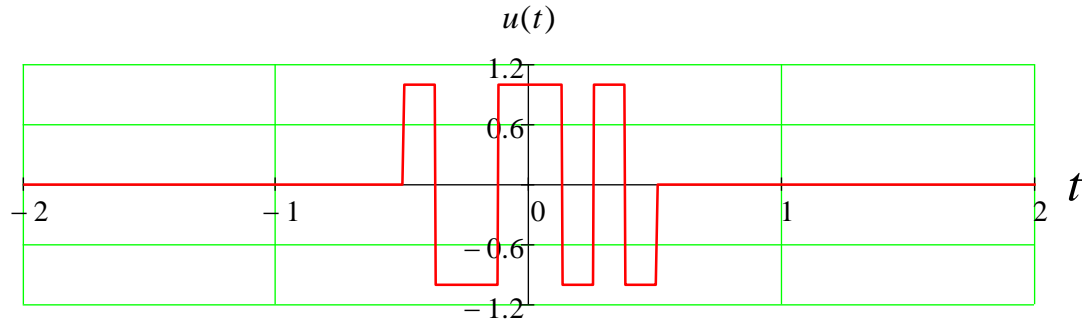


Преобразование сигнала в канале связи



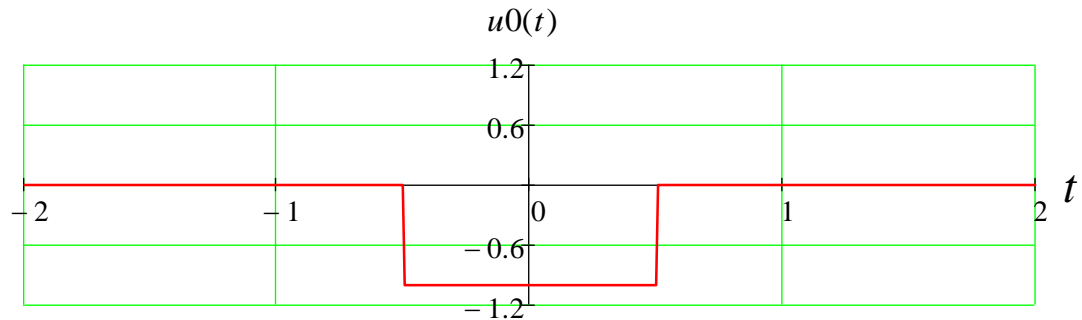
Многочастотный сигнал

$a_7 := 1$ $a_6 := 0$ $a_5 := 0$ $a_4 := 1$ $a_3 := 1$ $a_2 := 0$ $a_1 := 1$ $a_0 := 0$

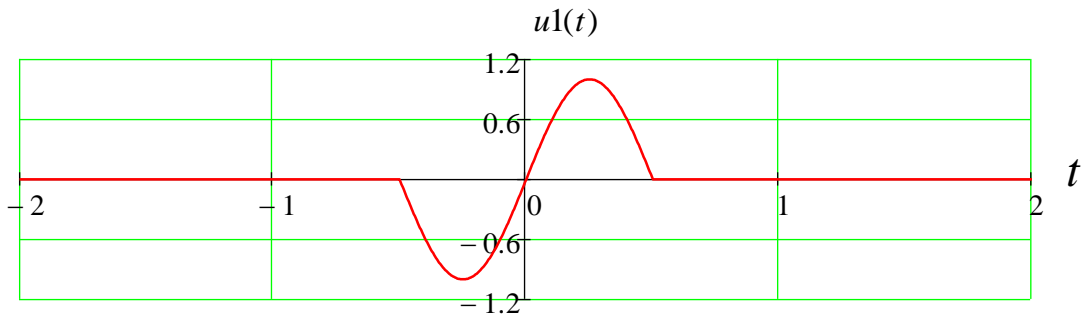


$$-\frac{T_0}{2} \leq t \leq \frac{T_0}{2}$$

$$\omega_0 = \frac{2 \cdot \pi}{T_0}$$



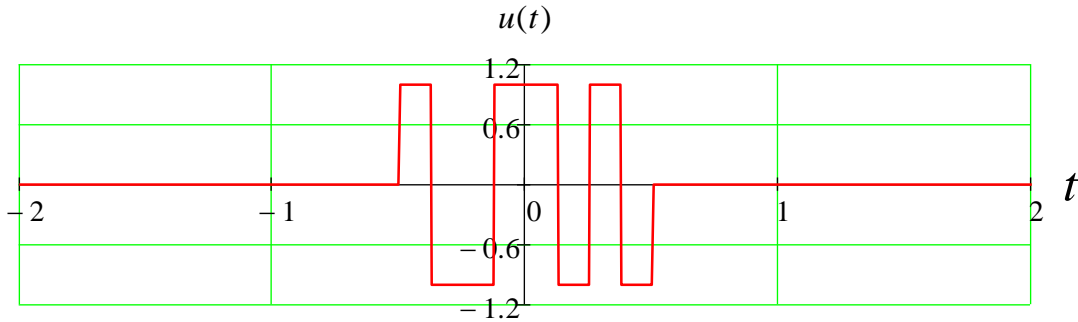
$$u_0(t) = 2 \cdot a_0 - 1$$



$$u_1(t) = (2 \cdot a_1 - 1) \cdot \sin(\omega_0 \cdot t)$$

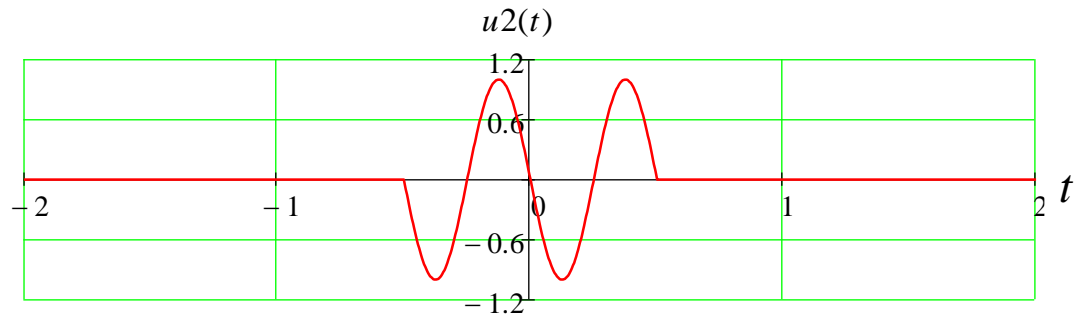
Многочастотный сигнал

$a_7:= 1$ $a_6:= 0$ $a_5:= 0$ $a_4:= 1$ $a_3:= 1$ $a_2:= 0$ $a_1:= 1$ $a_0:= 0$

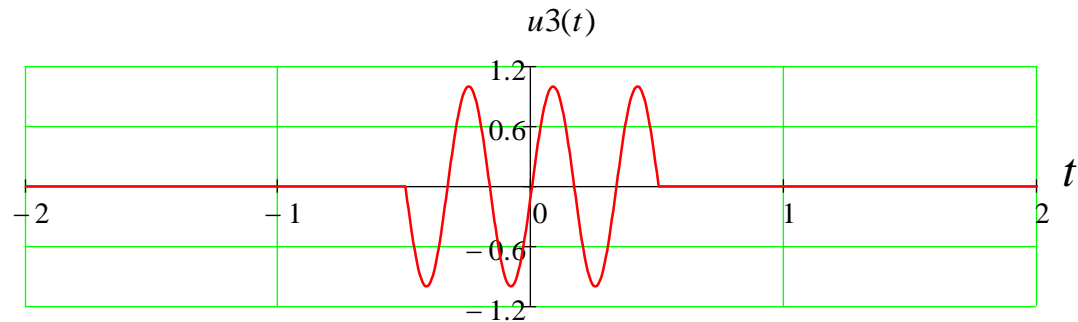


$$-\frac{T_0}{2} \leq t \leq \frac{T_0}{2}$$

$$\omega_0 = \frac{2 \cdot \pi}{T_0}$$



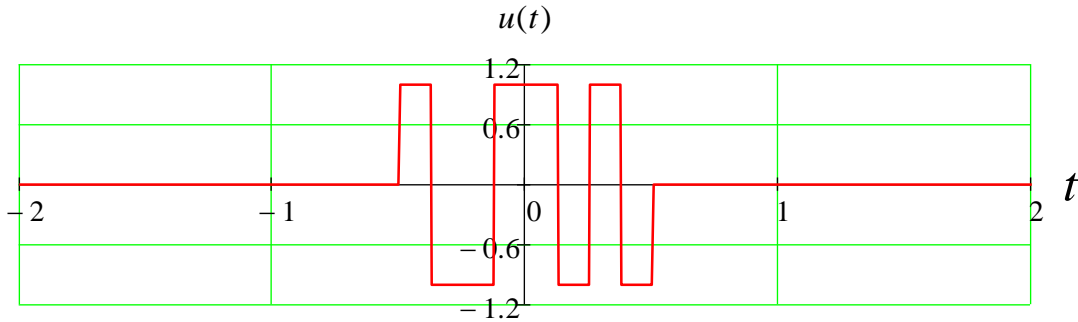
$$u_2(t) = (2 \cdot a_2 - 1) \cdot \sin(2 \cdot \omega_0 \cdot t)$$



$$u_3(t) = (2 \cdot a_3 - 1) \cdot \sin(3 \cdot \omega_0 \cdot t)$$

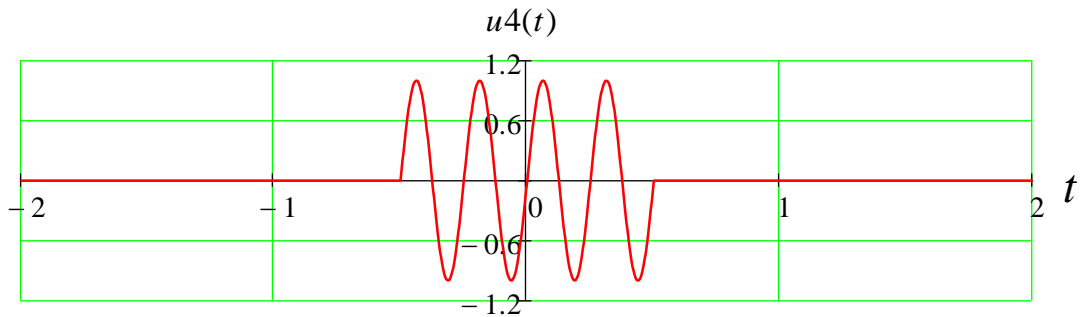
Многочастотный сигнал

$a_7 := 1$ $a_6 := 0$ $a_5 := 0$ $a_4 := 1$ $a_3 := 1$ $a_2 := 0$ $a_1 := 1$ $a_0 := 0$

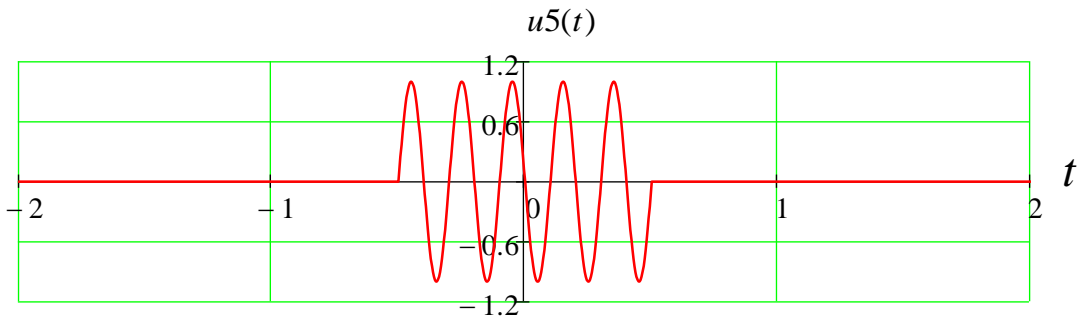


$$-\frac{T_0}{2} \leq t \leq \frac{T_0}{2}$$

$$\omega_0 = \frac{2 \cdot \pi}{T_0}$$



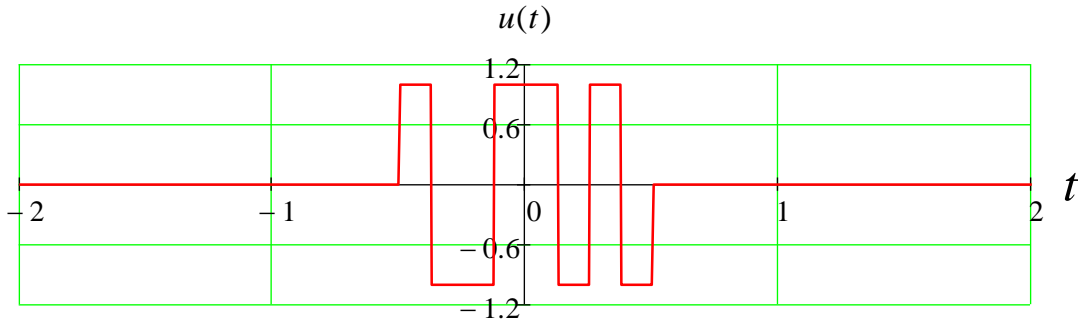
$$u_4(t) = (2 \cdot a_4 - 1) \cdot \sin(4 \cdot \omega_0 \cdot t)$$



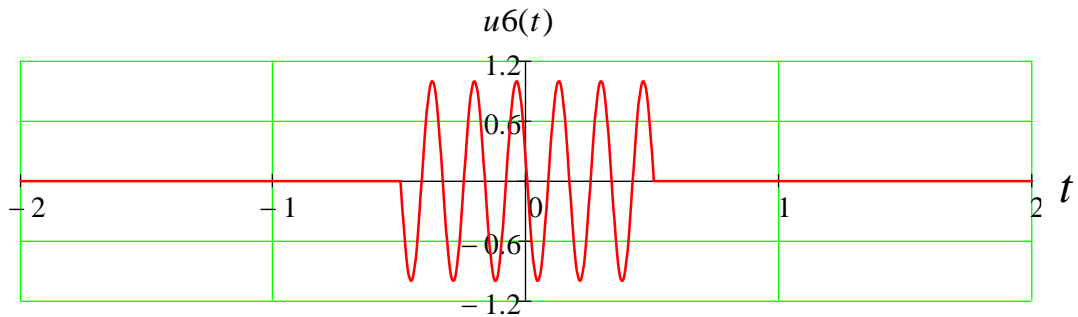
$$u_5(t) = (2 \cdot a_5 - 1) \cdot \sin(5 \cdot \omega_0 \cdot t)$$

Многочастотный сигнал

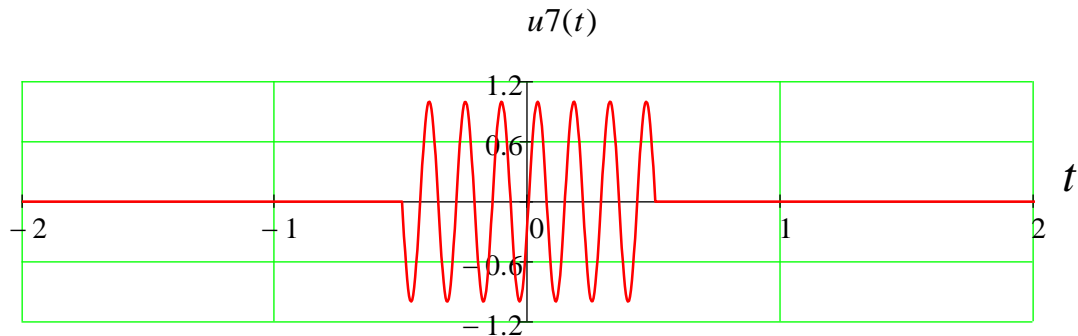
$a_7 := 1$ $a_6 := 0$ $a_5 := 0$ $a_4 := 1$ $a_3 := 1$ $a_2 := 0$ $a_1 := 1$ $a_0 := 0$



$$-\frac{T_0}{2} \leq t \leq \frac{T_0}{2}$$
$$\omega_0 = \frac{2 \cdot \pi}{T_0}$$



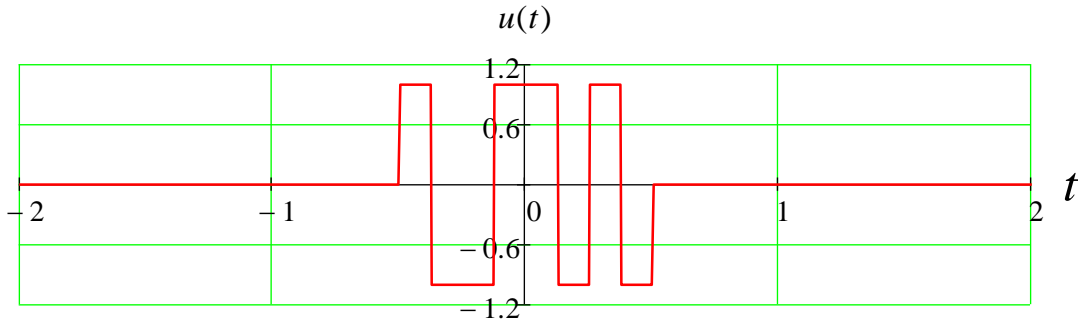
$$u_6(t) = (2 \cdot a_6 - 1) \cdot \sin(6 \cdot \omega_0 \cdot t)$$



$$u_7(t) = (2 \cdot a_7 - 1) \cdot \sin(7 \cdot \omega_0 \cdot t)$$

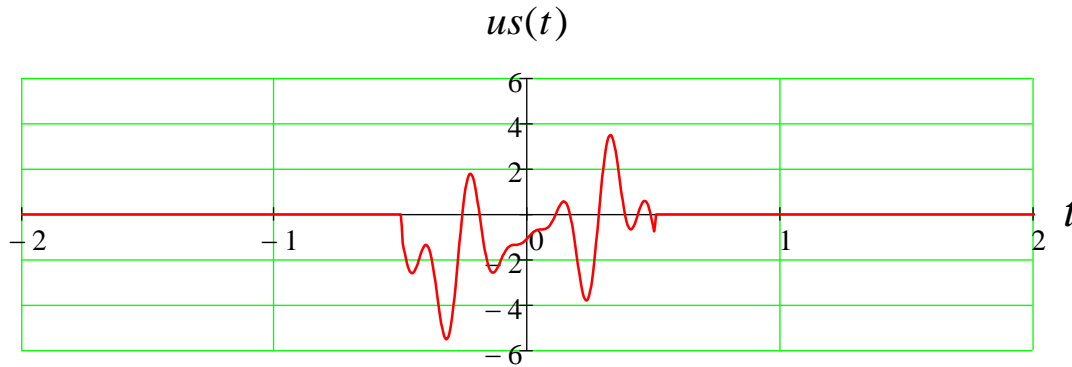
Многочастотный сигнал

$a_7 := 1$ $a_6 := 0$ $a_5 := 0$ $a_4 := 1$ $a_3 := 1$ $a_2 := 0$ $a_1 := 1$ $a_0 := 0$

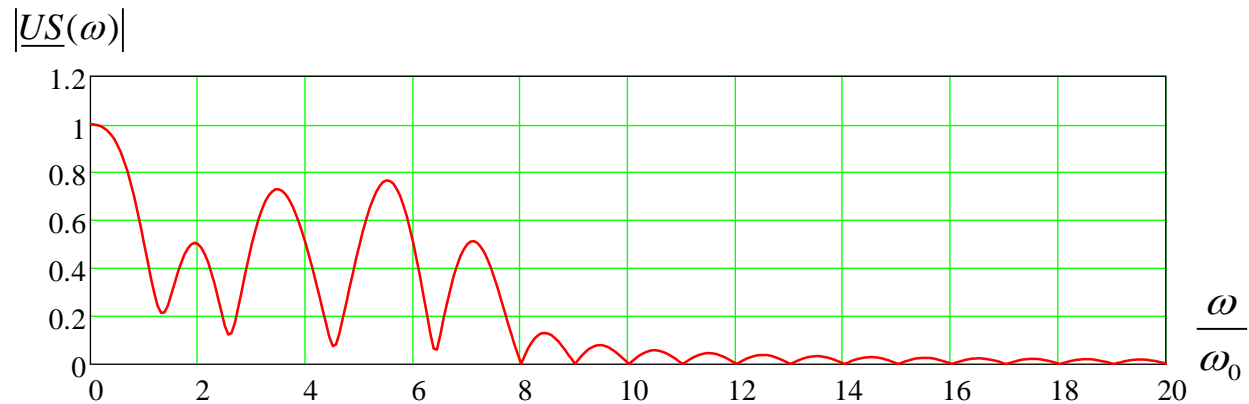
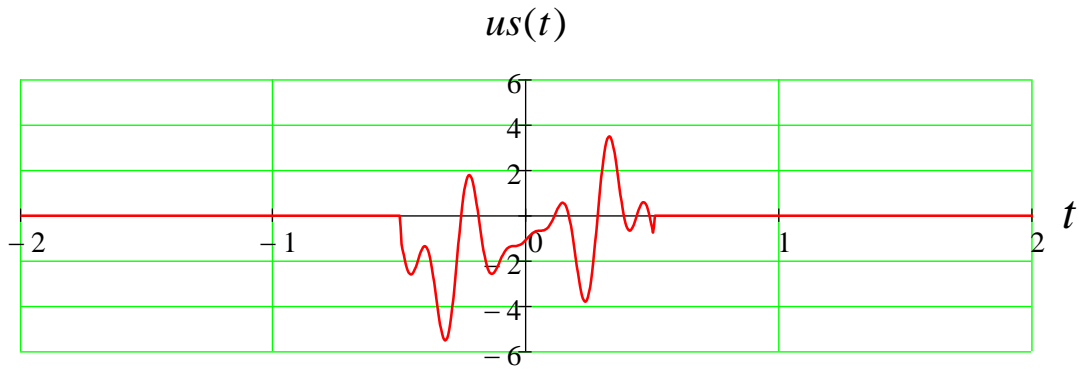


$$-\frac{T_0}{2} \leq t \leq \frac{T_0}{2}$$
$$\omega_0 = \frac{2 \cdot \pi}{T_0}$$

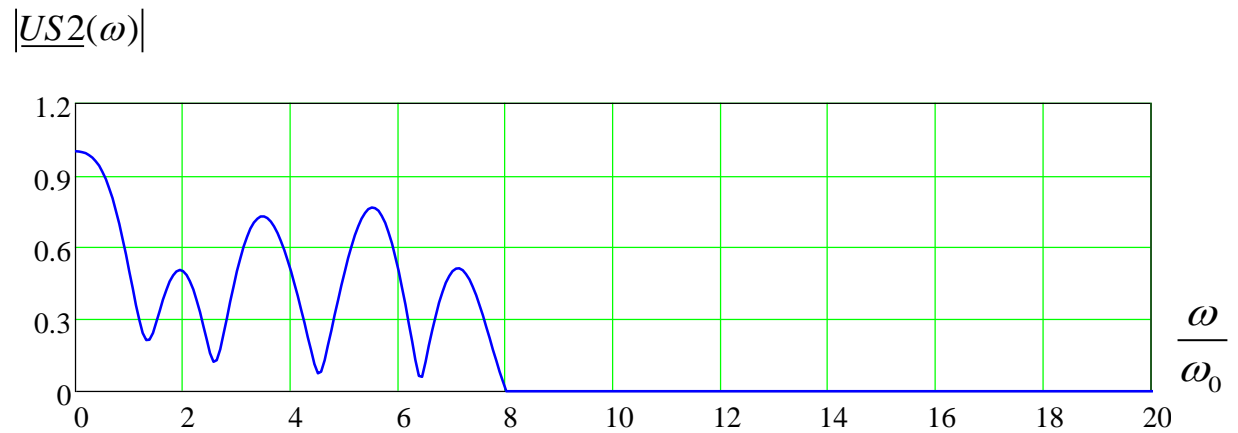
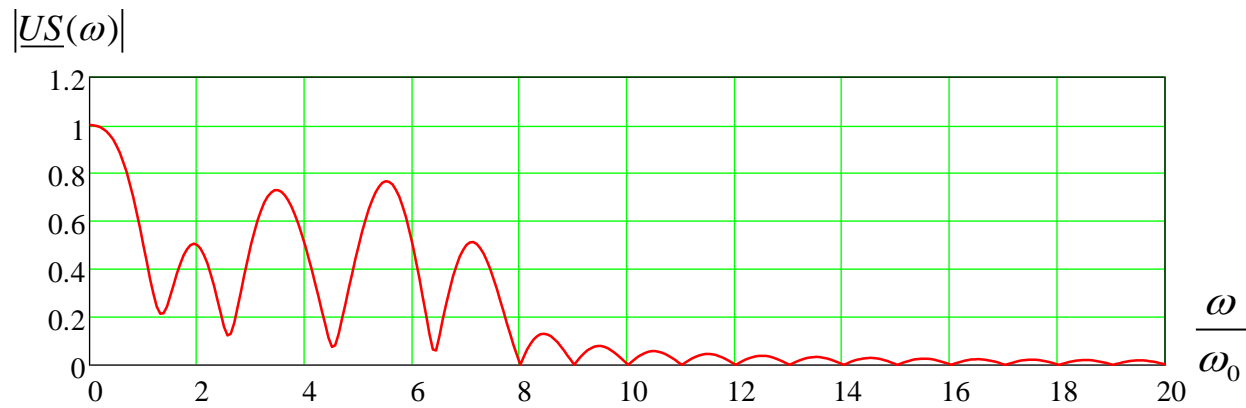
$$u_s(t) = u_0(t) + u_1(t) + u_2(t) + u_3(t) + u_4(t) + u_5(t) + u_6(t) + u_7(t)$$



Многочастотный сигнал

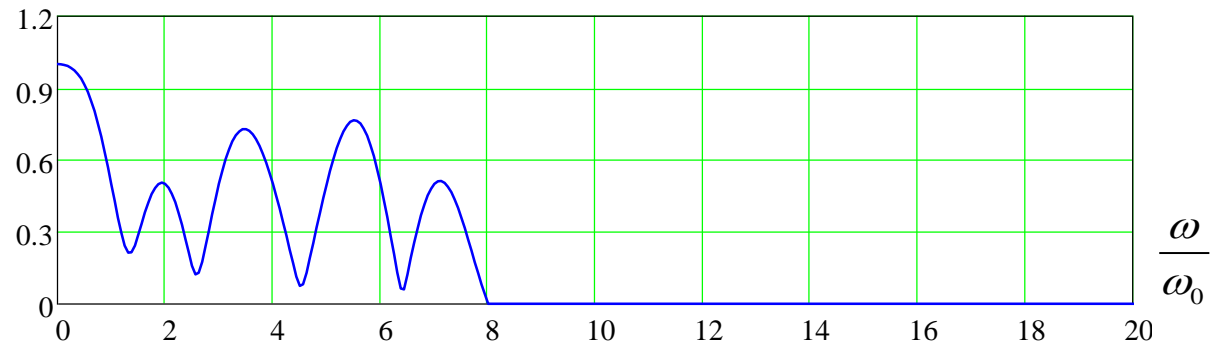


Многочастотный сигнал



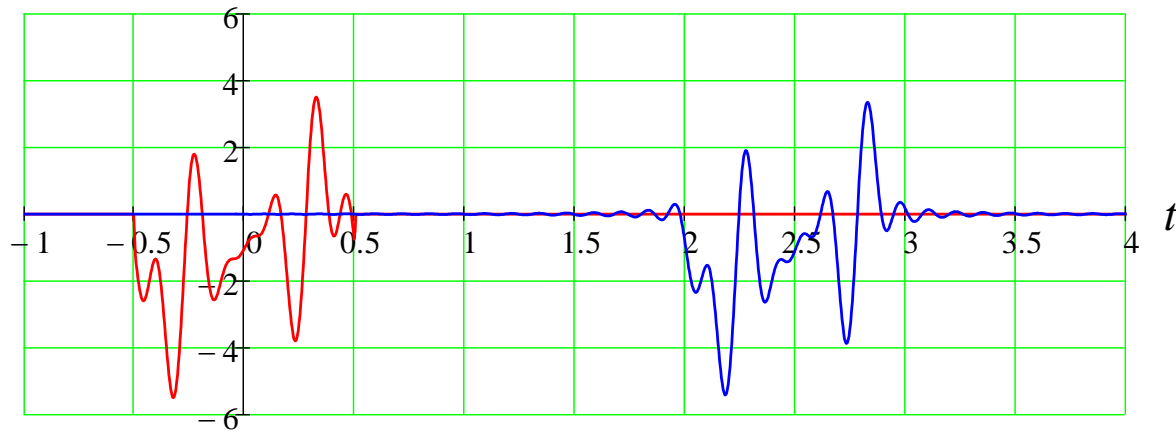
Многочастотный сигнал

$|US_2(\omega)|$



$us(t)$

$us_2(t)$



Спасибо за внимание.