Министерство образования Республики Беларусь

Учреждение образования

«Белорусский государственный университет информатики и радиоэлектроники»

Лабораторная работа №4

РАСЧЕТ СПЕКТРА СОСТАВНОГО ПЕРИОДИЧЕСКОГО СИГНАЛА И ЕГО ФИЛЬТРАЦИЯ В MATHCAD

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$fg := 13.2 \cdot 10^{6} \cdot 6 \qquad \underset{\wedge\wedge\wedge}{T} := 0.05 \cdot 10^{-3}$

$\underset{\wedge\wedge\wedge\wedge}{N} := T \cdot fg = 3.96 \times 10^{3}$

$2^{12} = 4.096 \times 10^{3} \qquad \underset{\wedge\wedge\wedge\wedge}{N} := 4096$

$$\tau := \frac{0.04 \cdot 10^{-3}}{12.2}$$

$$\tau 1 := \frac{0.01 \cdot 10^{-3}}{5}$$

$t\_offset := 5 \cdot \tau 1$

$a\_grow := 0 \qquad b\_grow := 0$

$t\_grow\_begin := 0 \qquad t\_grow\_end := 2 \cdot \tau 1$

$A\_grow\_begin := 0 \qquad A\_grow\_end := 2$

Given

$a\_grow \cdot t\_grow\_begin + b\_grow = A\_grow\_begin$

$a\_grow \cdot t\_grow\_end + b\_grow = A\_grow\_end$

$Sgrow := \text{Find}(a\_grow, b\_grow)$

$a\_decr := 0 \qquad b\_decr := 0$

$t\_decr\_begin := 2 \cdot \tau 1 \qquad t\_decr\_end := 4 \cdot \tau 1$

$A\_decr\_begin := 2 \qquad A\_decr\_end := 0$

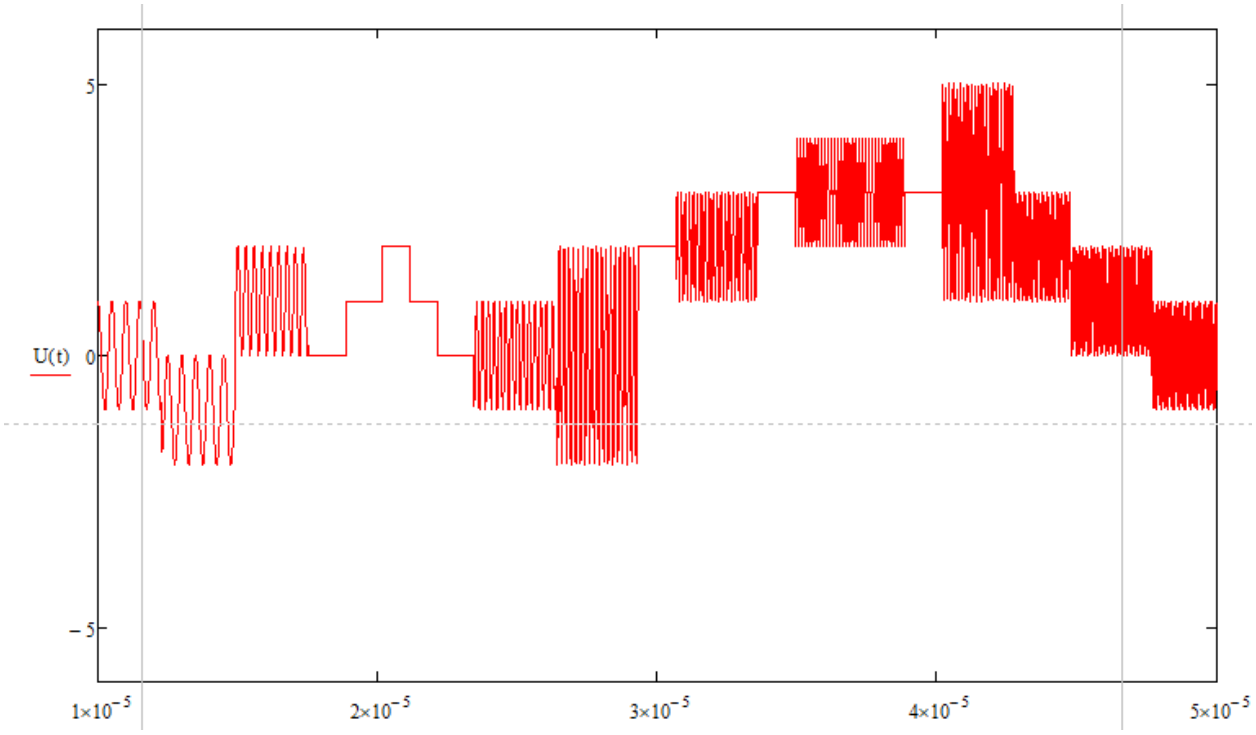
Given

$a\_decr \cdot t\_decr\_begin + b\_decr = A\_decr\_begin$

$a\_decr \cdot t\_decr\_end + b\_decr = A\_decr\_end$

$Sdecr := \text{Find}(a\_decr, b\_decr)$

$$U(t) := \begin{cases} 1 \cdot \cos\left(2 \cdot \pi \cdot 2 \cdot 10^{6} \cdot t\right) & \text{if } t\_offset < t \le t\_offset + 0.7\tau \\ \left(-1 + 1 \cdot \cos\left(2 \cdot \pi \cdot 2 \cdot 10^{6} \cdot t\right)\right) & \text{if } t\_offset + 0.7\tau < t \le t\_offset + 1.5\tau \\ \left(1 + 1 \cdot \cos\left(2 \cdot \pi \cdot 3.4 \cdot 10^{6} \cdot t\right)\right) & \text{if } t\_offset + 1.5\tau < t \le t\_offset + 2.3\tau \\ 0 & \text{if } t\_offset + 2.3\tau < t \le t\_offset + 2.7\tau \\ 1 & \text{if } t\_offset + 2.7\tau < t \le t\_offset + 3.1\tau \\ 2 & \text{if } t\_offset + 3.1\tau < t \le t\_offset + 3.4\tau \\ 1 & \text{if } t\_offset + 3.4\tau < t \le t\_offset + 3.7\tau \\ 0 & \text{if } t\_offset + 3.7\tau < t \le t\_offset + 4.1\tau \\ \left(0 + 1 \cdot \cos\left(2 \cdot \pi \cdot 4.8 \cdot 10^{6} \cdot t\right)\right) & \text{if } t\_offset + 4.1\tau < t \le t\_offset + 5\tau \\ \left(0 + 2 \cdot \cos\left(2 \cdot \pi \cdot 6 \cdot 10^{6} \cdot t\right)\right) & \text{if } t\_offset + 5\tau < t \le t\_offset + 5.9\tau \\ 2 & \text{if } t\_offset + 5.9\tau < t \le t\_offset + 6.3\tau \\ \left(2 + 1 \cdot \cos\left(2 \cdot \pi \cdot 7 \cdot 10^{6} \cdot t\right)\right) & \text{if } t\_offset + 6.3\tau < t \le t\_offset + 7.2\tau \\ 3 & \text{if } t\_offset + 7.2\tau < t \le t\_offset + 7.6\tau \\ \left(3 + 1 \cdot \cos\left(2 \cdot \pi \cdot 8.2 \cdot 10^{6} \cdot t\right)\right) & \text{if } t\_offset + 7.6\tau < t \le t\_offset + 8.8\tau \\ 3 & \text{if } t\_offset + 8.8\tau < t \le t\_offset + 9.2\tau \\ \left(3 + 2 \cdot \cos\left(2 \cdot \pi \cdot 9.6 \cdot 10^{6} \cdot t\right)\right) & \text{if } t\_offset + 9.2\tau < t \le t\_offset + 10\tau \\ \left(2 + 1 \cdot \cos\left(2 \cdot \pi \cdot 11 \cdot 10^{6} \cdot t\right)\right) & \text{if } t\_offset + 10\tau < t \le t\_offset + 10.6\tau \\ \left(1 + 1 \cdot \cos\left(2 \cdot \pi \cdot 12.4 \cdot 10^{6} \cdot t\right)\right) & \text{if } t\_offset + 10.6\tau < t \le t\_offset + 11.5\tau \\ \left(0 + 1 \cdot \cos\left(2 \cdot \pi \cdot 12.4 \cdot 10^{6} \cdot t\right)\right) & \text{if } t\_offset + 11.5\tau < t \le t\_offset + 12.2\tau \end{cases} \qquad t := 0, \frac{T}{N} .. T$$

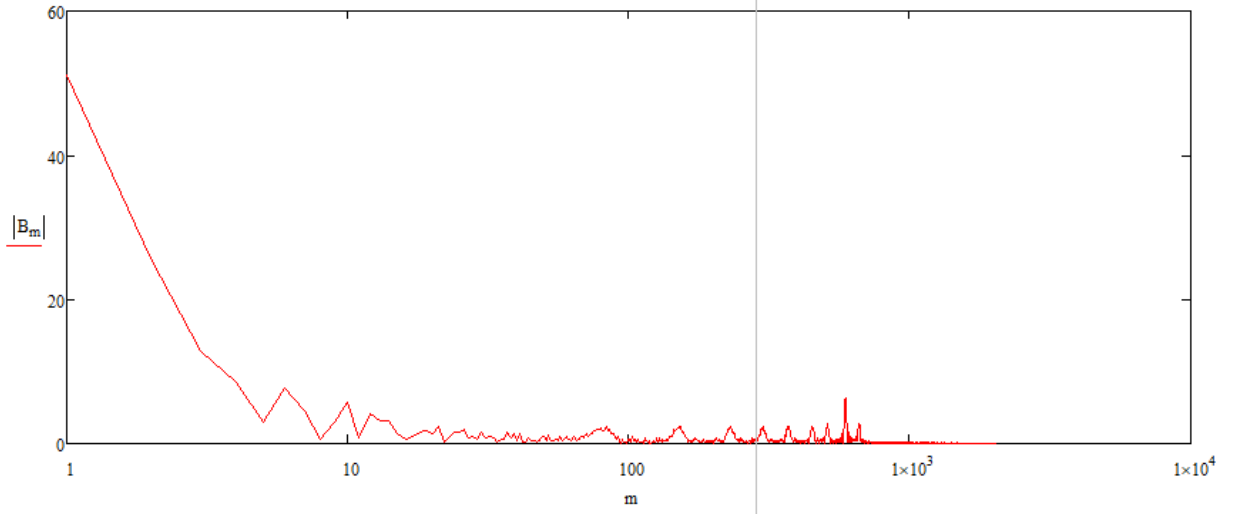


Спектр исходного сингнала:

$k := 0..N-1 \qquad \Delta t := \frac{T}{N}$

$V_k := U(k \cdot \Delta t)$

$B := fft(V) \qquad m := 0..\frac{N}{2}$

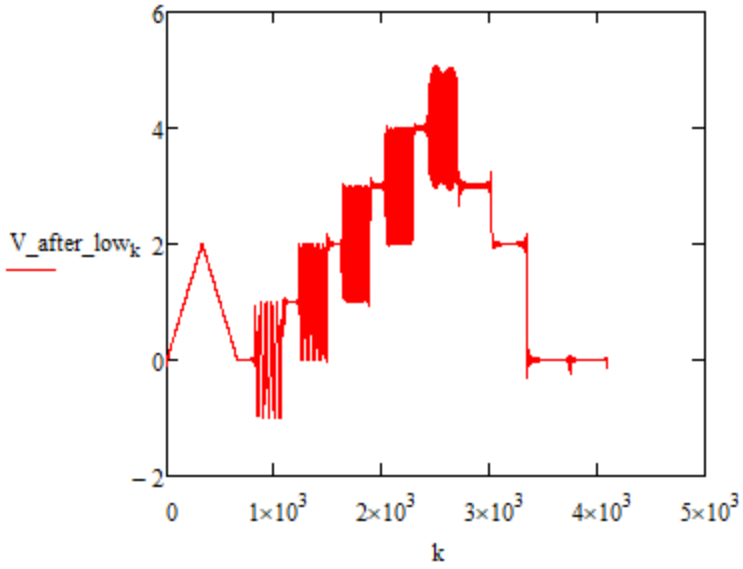


Сигнал после ФНЧ:

low_cutoff := 400

$$B\_low\_filter_m := \begin{cases} B_m & \text{if } m < low\_cutoff \\ 0 & \text{otherwise} \end{cases}$$

V_after_low := ifft(B_low_filter)

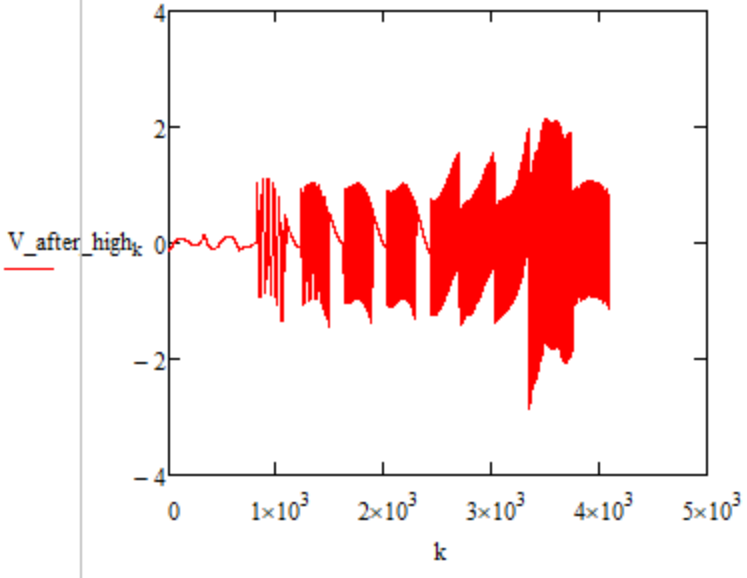


Сигнал после ФВЧ:

high_cutoff := 10

$$B\_high\_filter_m := \begin{cases} B_m & \text{if } m > high\_cutoff \\ 0 & \text{otherwise} \end{cases}$$

V_after_high := ifft(B_high_filter)



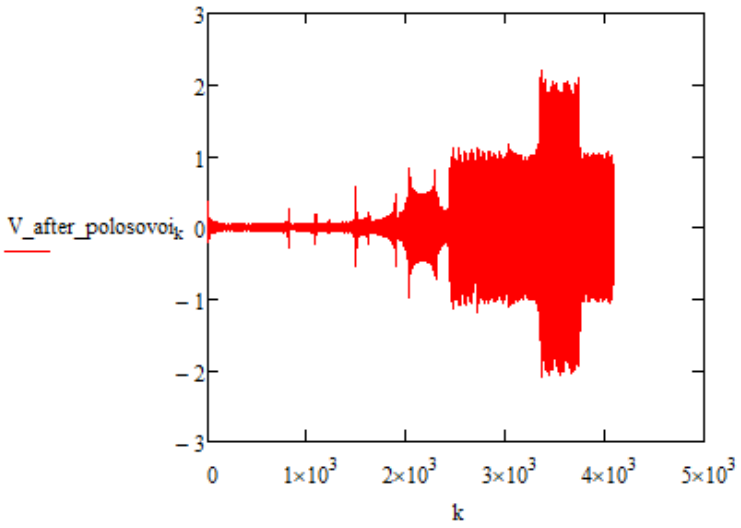
Сигнал после полосового фильтра

polosovoi_low := 300

polosovoi_high := 700

$$B\_polosovoi\_filter_m := \begin{cases} B_m & \text{if } polosovoi\_low < m \le polosovoi\_high \\ 0 & \text{otherwise} \end{cases}$$

V_after_polosovoi := ifft(B_polosovoi_filter)



Сигнал после заграждающего фильтра

zagrazhd_low := 300

zagrazhd_high := 700

$$B\_zagrazhd\_filter_m := \begin{cases} 0 & \text{if } polosovoi\_low < m \le polosovoi\_high \\ B_m & \text{otherwise} \end{cases}$$

V_after_zagrazhd := ifft(B_zagrazhd_filter)