Частотные свойства

$$H(\omega,b1,b2) := \frac{b2 + 1 - |b1|}{\sqrt{4\cdot b2\cdot\cos(\omega)^2 + [2\cdot b1\cdot(1+b2)\cdot\cos(\omega)] + [b1^2 + (1-b2)\cdot 2]}}$$

$$A(b1,b2) := 4b2 \qquad B(b1,b2) := 2\cdot b1\cdot(1+b2) \qquad C(b1,b2) := b1^2 + (1-b2)^2$$

$$\omega c1(b1,b2) := \operatorname{acos}\left[\frac{-B(b1,b2) + \sqrt{B(b1,b2)^2 - 4\cdot A(b1,b2)\cdot[C(b1,b2) - 2\cdot[b2 + 1 - (|b1|)^2]]}}{2\cdot A(b1,b2)}\right]$$

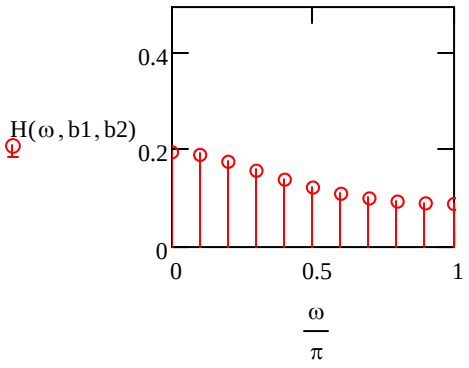
$$\omega c2(b1,b2) := \operatorname{acos}\left[\frac{-B(b1,b2) - \sqrt{B(b1,b2)^2 - 4\cdot A(b1,b2)\cdot[C(b1,b2) - 2\cdot[b2 + 1 - (|b1|)^2]]}}{2\cdot A(b1,b2)}\right]$$

$$\phi(\omega,b1,b2) := \operatorname{atan}\left(\frac{b1\cdot\sin(\omega) + b2\cdot\sin(2\omega)}{1 + b1\cdot\cos(\omega) + b2\cdot\cos(2\omega)}\right)$$

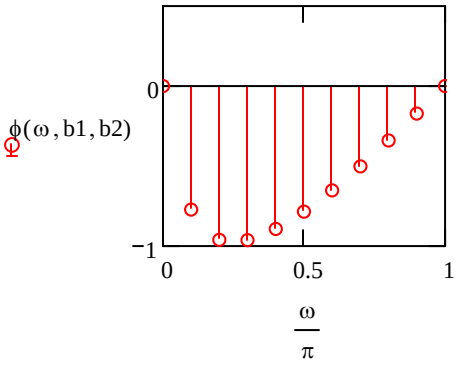
$\omega := 0, 0.1\pi .. \pi$

**ФНЧ**

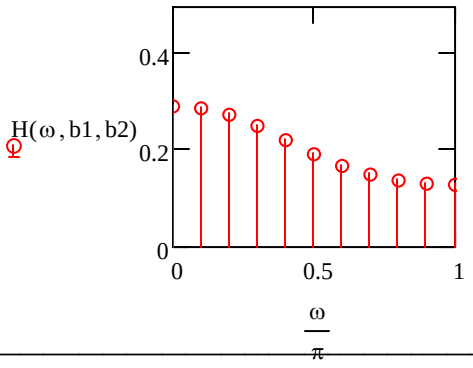
$b1 := -0.9 \quad b2 := 0.1$



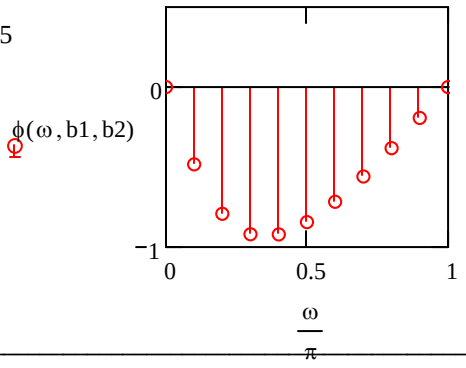

$\omega c2(b1,b2) = 0.931$



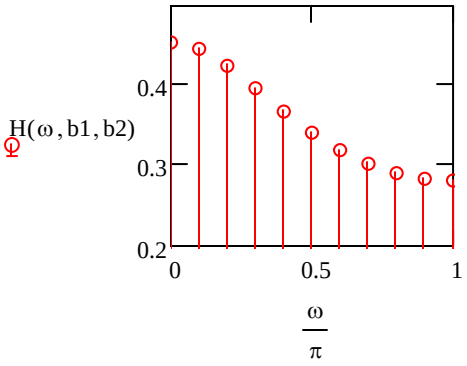

$b1 := -0.9 \quad b2 := 0.2$



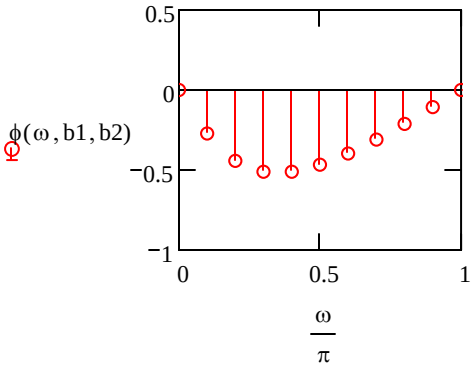

$\omega c2(b1,b2) = 1.205$



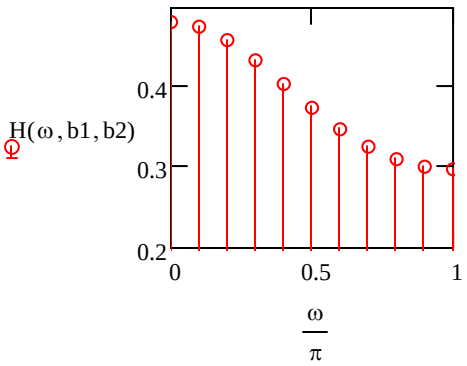
b1 := −0.5 b2 := 0.01



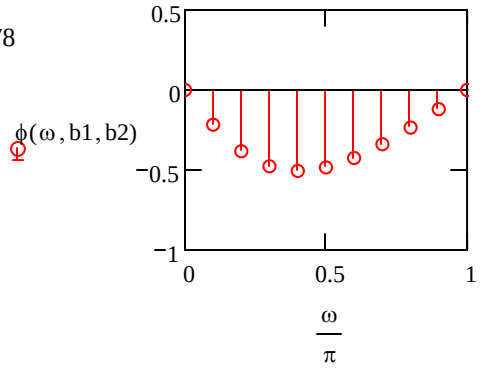

ωc2(b1, b2) = 1.859




b1 := −0.5 b2 := 0.05

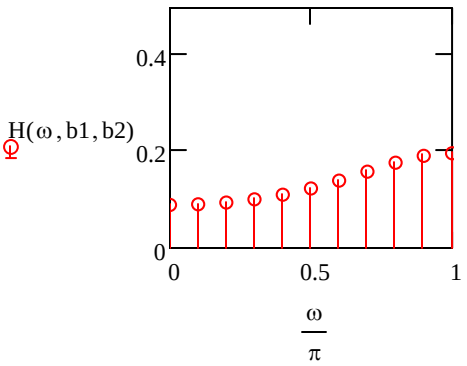



ωc2(b1, b2) = 1.978

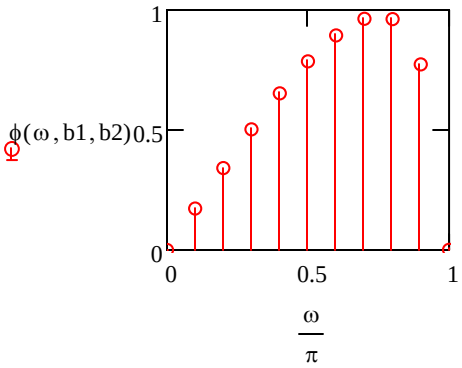



**ФВЧ**

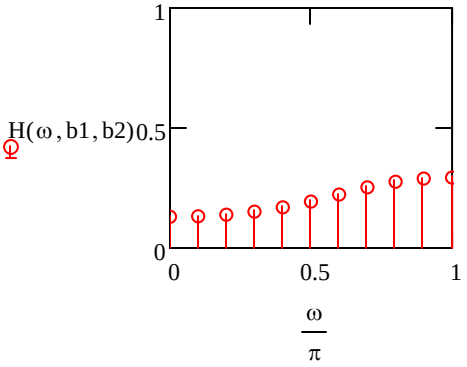
b1 := 0.9 b2 := 0.1



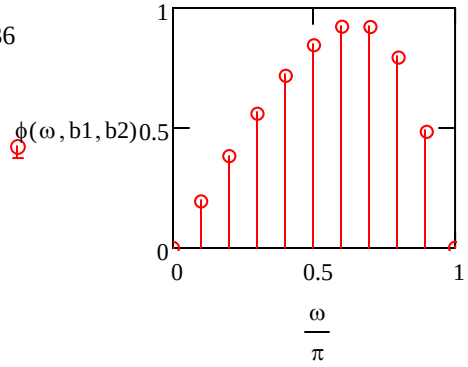

ωc1(b1, b2) = 2.211



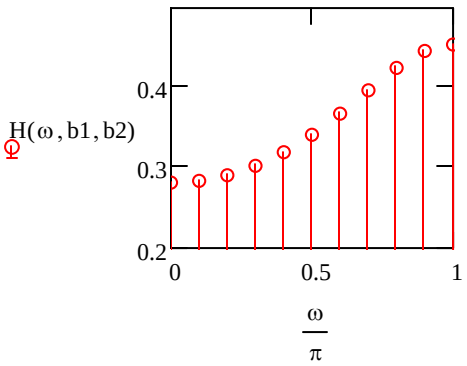

b1 := 0.9 b2 := 0.2



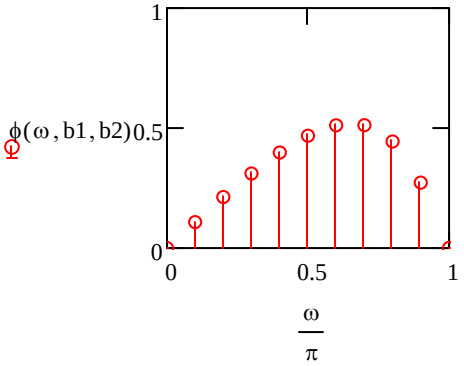

ωc1(b1, b2) = 1.936



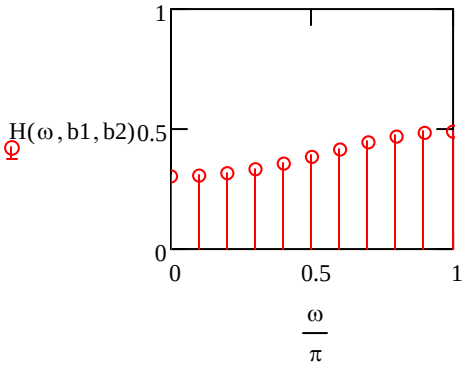
b1 := 0.5  b2 := 0.01



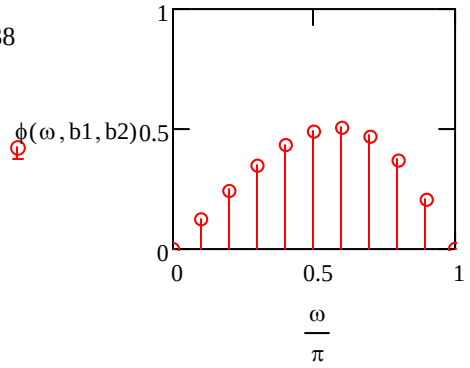

ωc1(b1, b2) = 1.283




b1 := 0.5  b2 := 0.06




ωc1(b1, b2) = 1.138

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**Полосовой Фильтр**

$$wr(b1,b2) := \operatorname{acos}\left[\frac{-b1\cdot(1+b2)}{4b2}\right]$$

$$a1(b1,b2) := \frac{-B(b1,b2) + \sqrt{-B(b1,b2)^2 + 4\,A(b1,b2)\cdot C(b1,b2)}}{2\,A(b1,b2)}$$

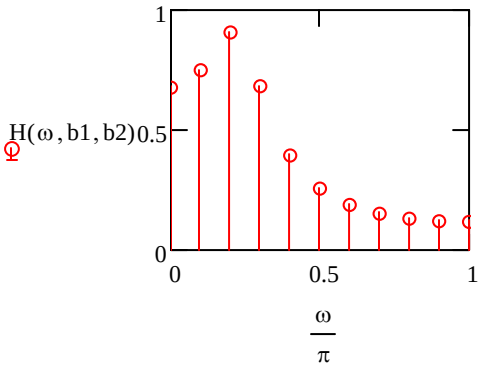
$$a2(b1,b2) := \frac{-B(b1,b2) - \sqrt{-B(b1,b2)^2 + 4\cdot A(b1,b2)\cdot C(b1,b2)}}{2\cdot A(b1,b2)}$$

$$Q(b1,b2) := \frac{wr(b1,b2)}{\operatorname{acos}(a2(b1,b2)) - \operatorname{acos}(a1(b1,b2))}$$

$$w1(b1,b2) := \operatorname{acos}(a1(b1,b2))$$

$$w2(b1,b2) := \operatorname{acos}(a2(b1,b2))$$

b2 := 0.9  b1 := −1.5

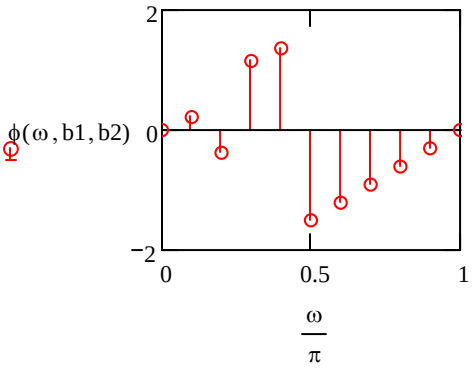


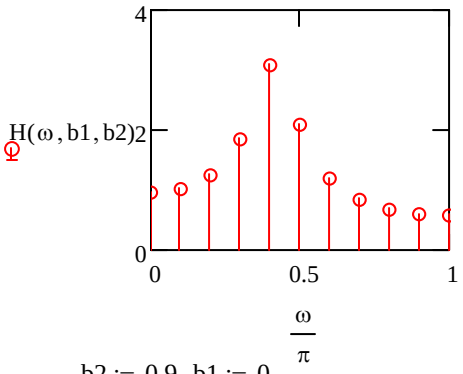

wr(b1, b2) = 0.657

w2(b1, b2) = 0.708

w1(b1, b2) = 0.602

Q(b1, b2) = 6.203



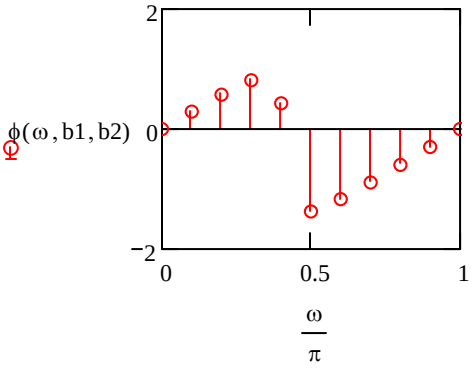



wr(b1, b2) = 1.304

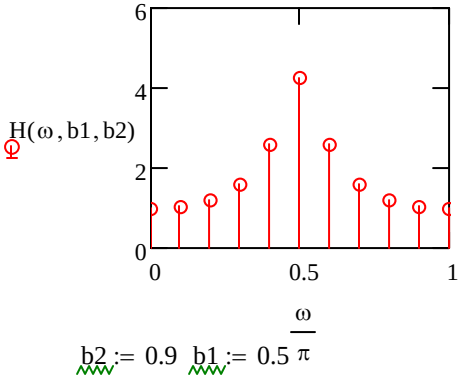
w2(b1, b2) = 1.356

w1(b1, b2) = 1.251

Q(b1, b2) = 12.36




b2 := 0.9 b1 := 0

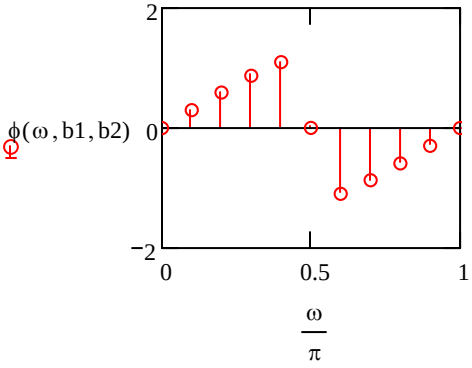



wr(b1, b2) = 1.571

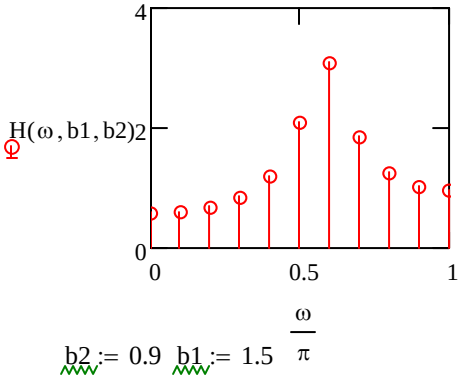
w2(b1, b2) = 1.624

w1(b1, b2) = 1.518

Q(b1, b2) = 14.895




b2 := 0.9 b1 := 0.5

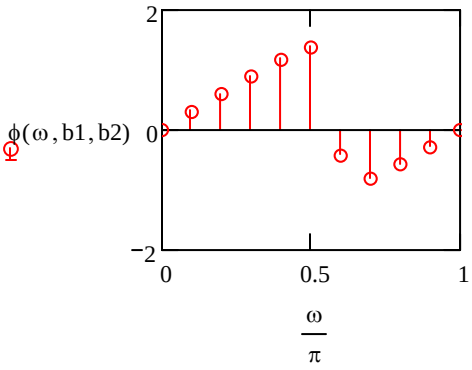



wr(b1, b2) = 1.838

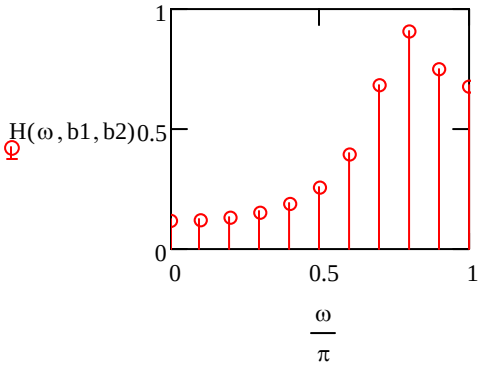
w2(b1, b2) = 1.891

w1(b1, b2) = 1.785

Q(b1, b2) = 17.424




b2 := 0.9 b1 := 1.5

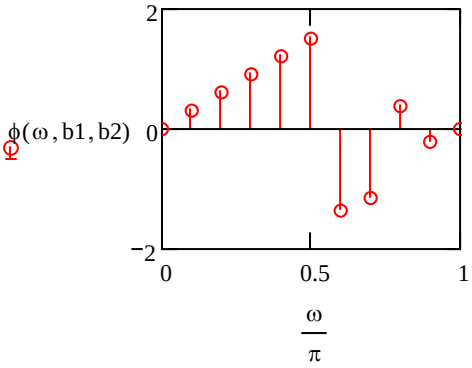


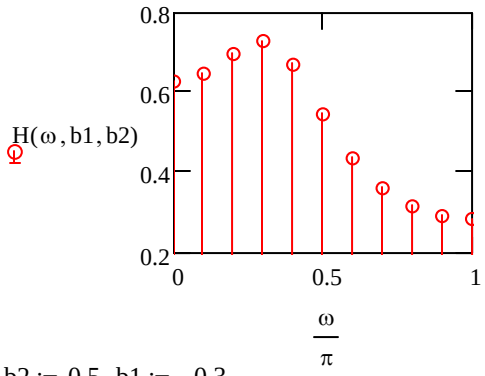

wr(b1, b2) = 2.484

w2(b1, b2) = 2.539

w1(b1, b2) = 2.433

Q(b1, b2) = 23.447



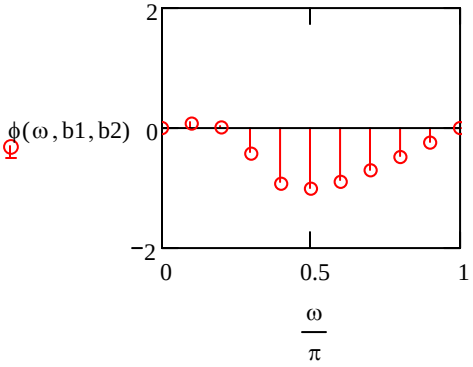



wr(b1, b2) = 0.927

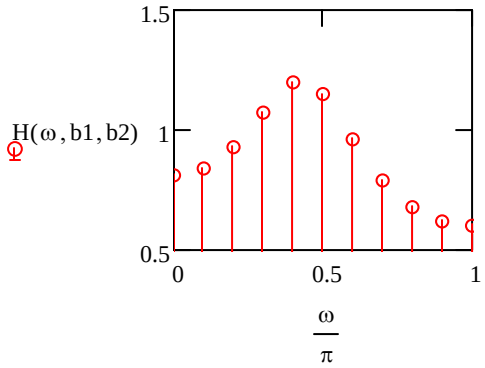
w2(b1, b2) = 1.257

w1(b1, b2) = 0.47

Q(b1, b2) = 1.178




b2 := 0.5 b1 := −0.3

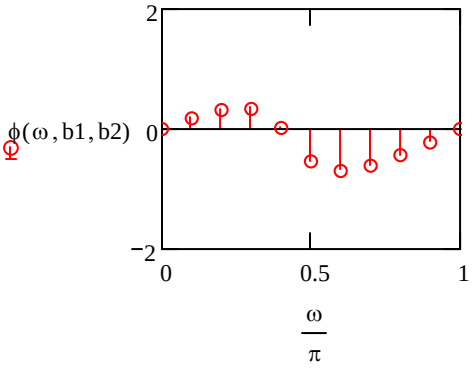



wr(b1, b2) = 1.344

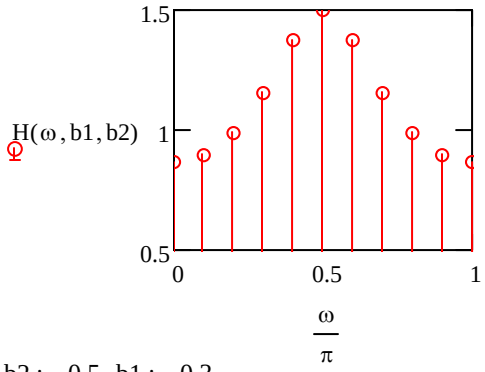
w2(b1, b2) = 1.692

w1(b1, b2) = 0.964

Q(b1, b2) = 1.846




b2 := 0.5 b1 := 0

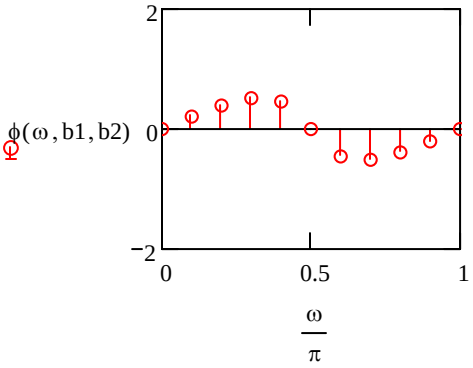



wr(b1, b2) = 1.571

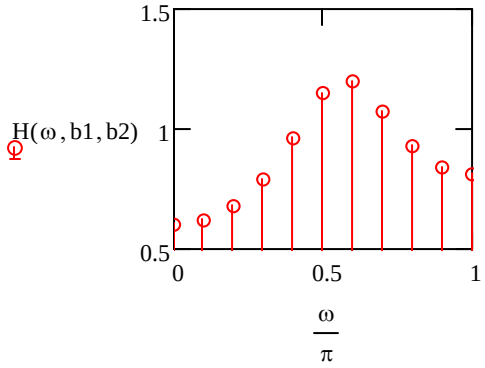
w2(b1, b2) = 1.932

w1(b1, b2) = 1.209

Q(b1, b2) = 2.173




b2 := 0.5 b1 := 0.3

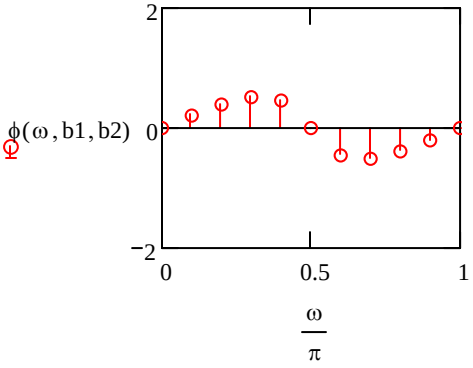



wr(b1, b2) = 1.798

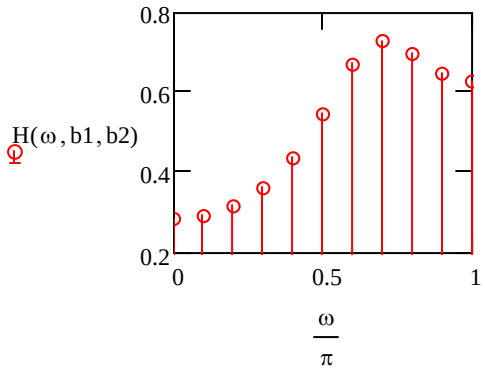
w2(b1, b2) = 2.178

w1(b1, b2) = 1.45

Q(b1, b2) = 2.47




b2 := 0.5 b1 := 0.8

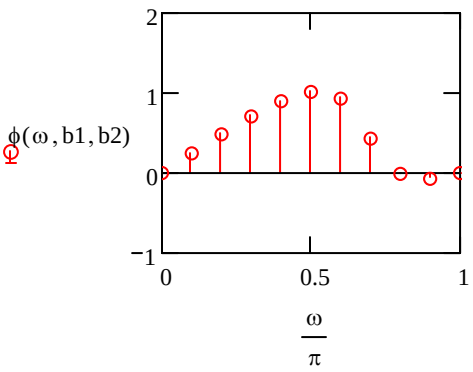



wr(b1, b2) = 2.214

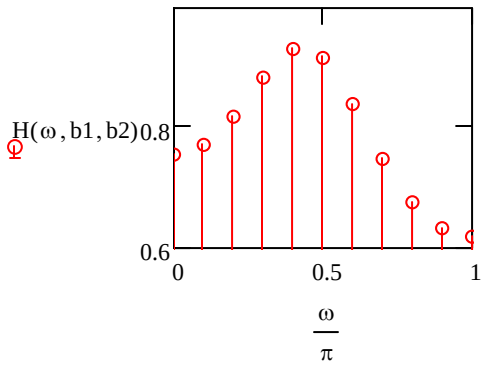
w2(b1, b2) = 2.672

w1(b1, b2) = 1.884

Q(b1, b2) = 2.813




b2 := 0.3 b1 := −0.2

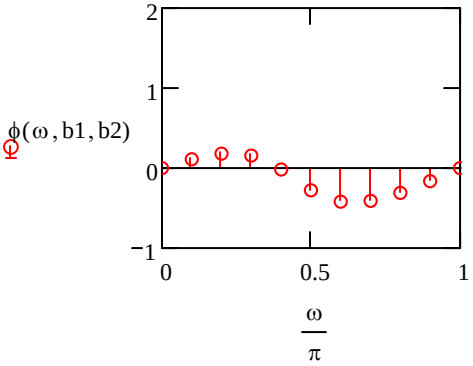



wr(b1, b2) = 1.352

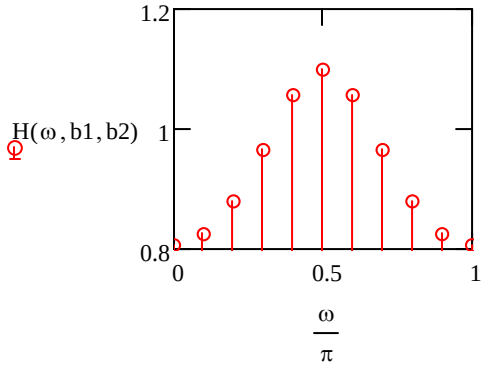
w2(b1, b2) = 1.995

w1(b1, b2) = 0.564

Q(b1, b2) = 0.945




b2 := 0.3 b1 := 0

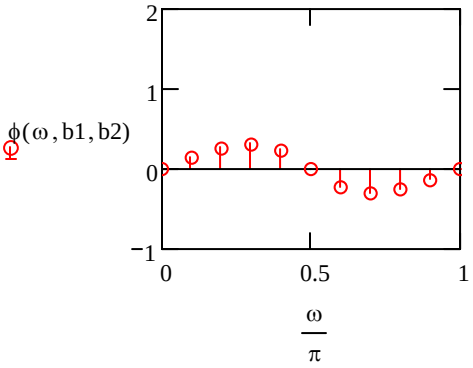



wr(b1, b2) = 1.571

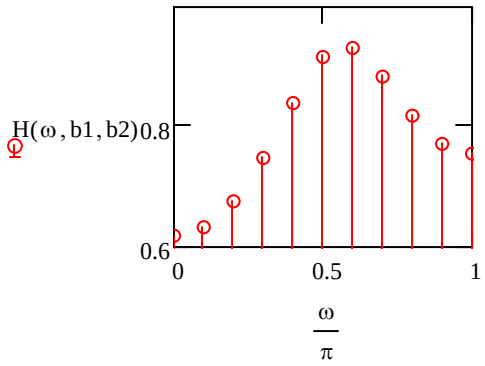
w2(b1, b2) = 2.264

w1(b1, b2) = 0.878

Q(b1, b2) = 1.133




b2 := 0.3 b1 := 0.2

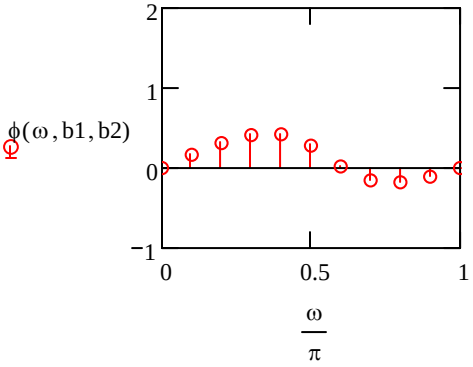



wr(b1, b2) = 1.789

w2(b1, b2) = 2.577

w1(b1, b2) = 1.147

Q(b1, b2) = 1.251






**Режекторный Фильтр**

$$a1(b1,b2) := \frac{-B(b1,b2) + \sqrt{\frac{B(b1,b2)^2 - 4\cdot A(b1,b2)\cdot C(b1,b2)}{2}}}{2\cdot A(b1,b2)} \qquad wr(b1,b2) := \operatorname{acos}\left[\frac{-b1\cdot(1+b2)}{4b2}\right]$$

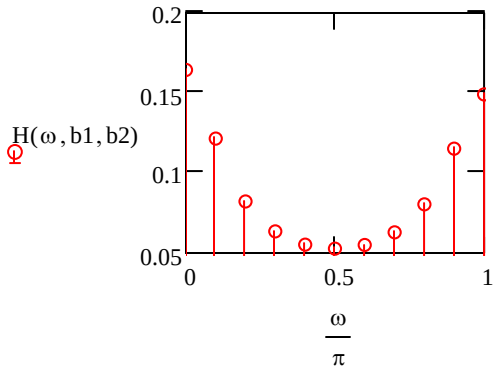
$$a2(b1,b2) := \frac{-B(b1,b2) - \sqrt{\frac{B(b1,b2)^2 - 4\cdot A(b1,b2)\cdot C(b1,b2)}{2}}}{2\cdot A(b1,b2)}$$

$$w1(b1,b2) := \operatorname{acos}(a1(b1,b2))$$

$$w2(b1,b2) := \operatorname{acos}(a2(b1,b2))$$

$$Q(b1,b2) := \frac{wr(b1,b2)}{\operatorname{acos}(a2(b1,b2)) - \operatorname{acos}(a1(b1,b2))}$$

$b2 := -0.8$ $b1 := -0.1$

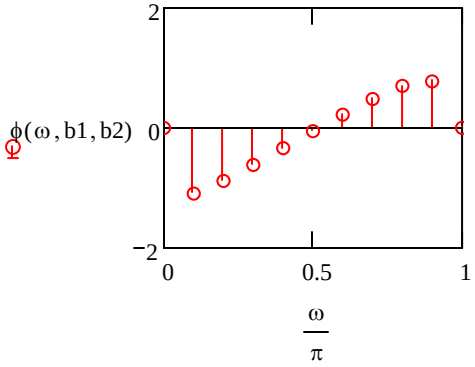



$wr(b1,b2) = 1.577$

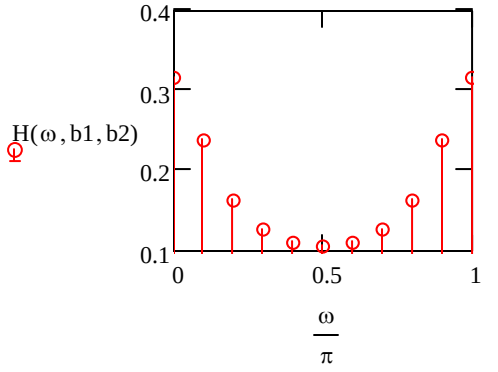
$w2(b1,b2) = 0.786$

$w1(b1,b2) = 2.373$

$Q(b1,b2) = -0.994$




$b2 := -0.8$ $b1 := 0$

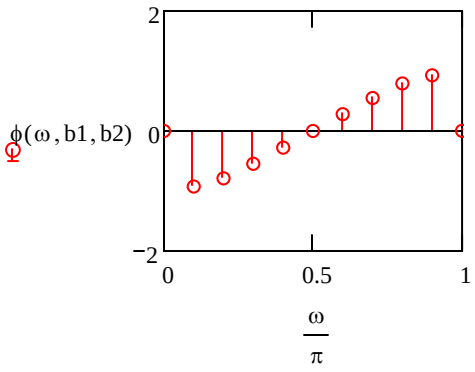



$wr(b1,b2) = 1.571$

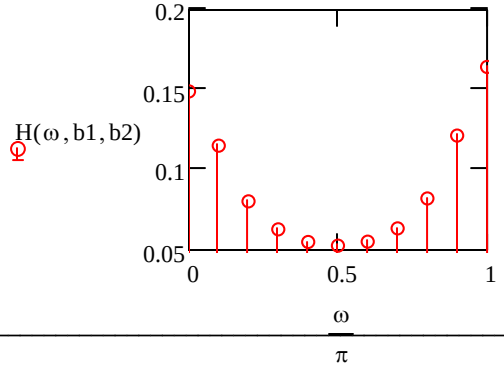
$w2(b1,b2) = 0.779$

$w1(b1,b2) = 2.362$

$Q(b1,b2) = -0.992$




$b2 := -0.8$ $b1 := 0.1$

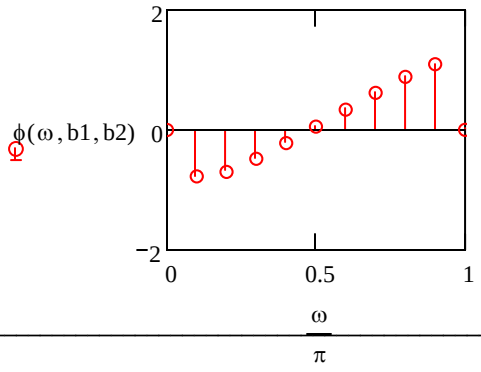



$wr(b1,b2) = 1.565$

$w2(b1,b2) = 0.769$

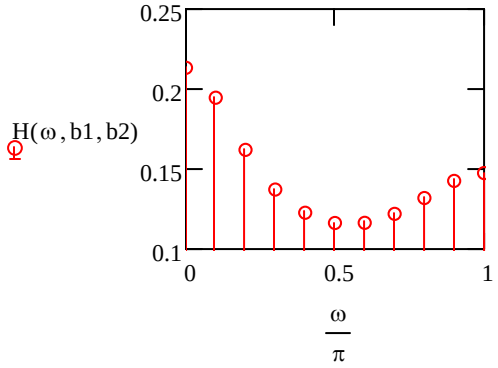
$w1(b1,b2) = 2.355$

$Q(b1,b2) = -0.986$






$b1 := -0.4$ $b2 := -0.4$

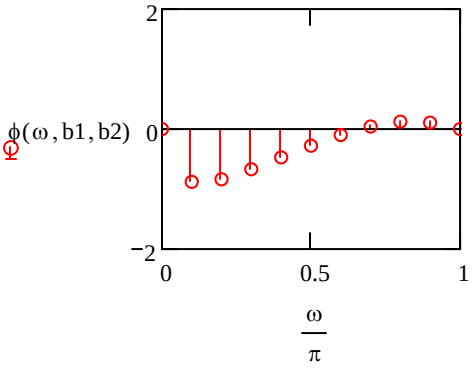



wr(b1, b2) = 1.721

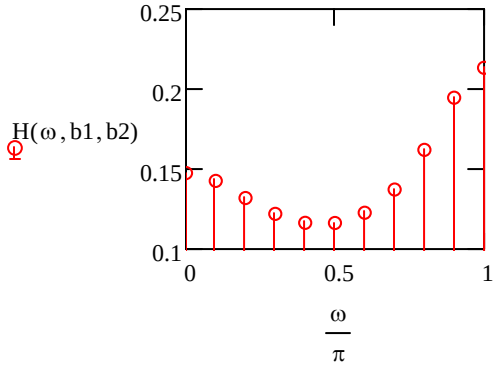
w2(b1, b2) = 0.835

w1(b1, b2) = 2.899

Q(b1, b2) = −0.834




b1 := 0.4  b2 := −0.4

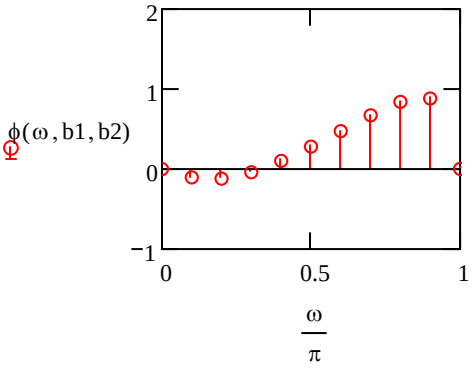



wr(b1, b2) = 1.42

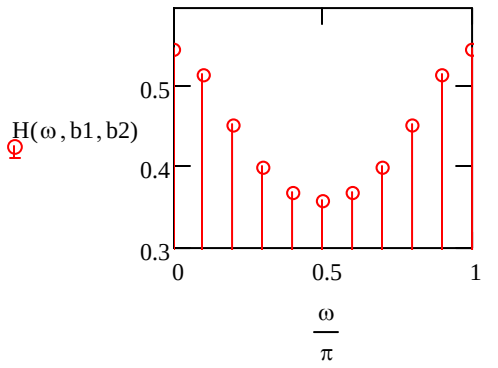
w2(b1, b2) = 0.242

w1(b1, b2) = 2.306

Q(b1, b2) = −0.688




b1 := 0  b2 := −0.4

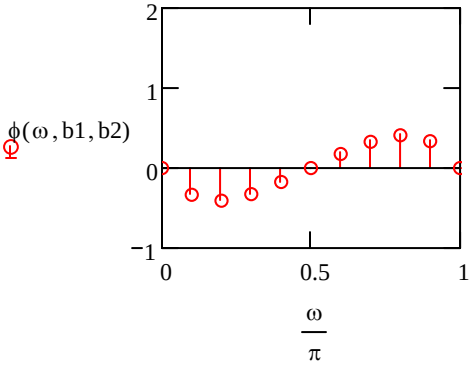



wr(b1, b2) = 1.571

w2(b1, b2) = 0.672

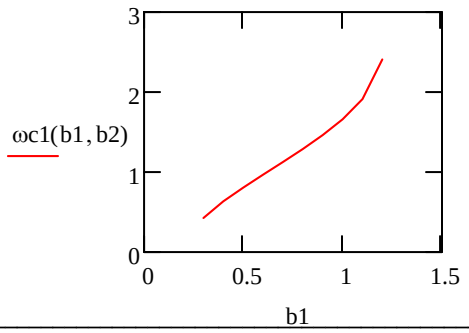
w1(b1, b2) = 2.47

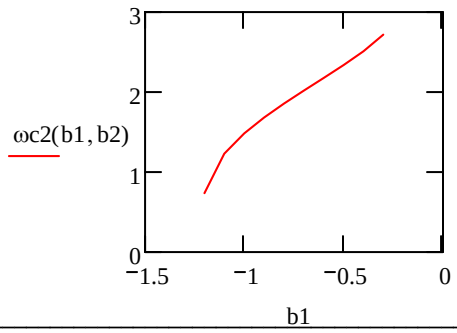
Q(b1, b2) = −0.874



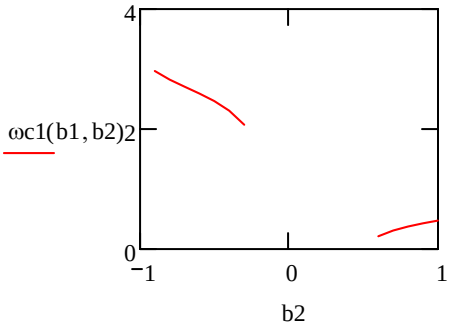

**Графики зависимостей ωc от ь1 и ь2 для ФНЧ и ФВЧ**

b1 := −2, −1.9 .. 2  b2 := 0.5




b2 := −1, −0.9 .. 1  b1 := 0.2



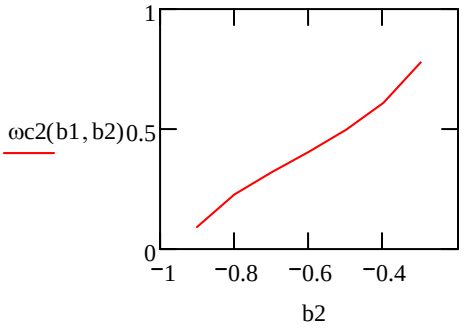
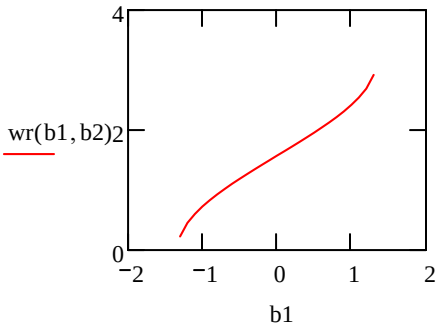
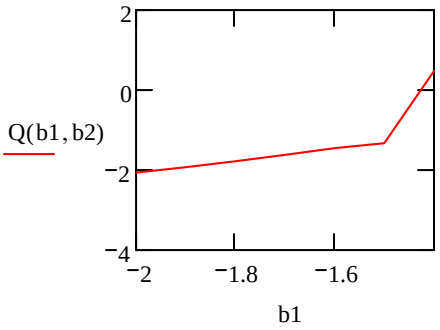



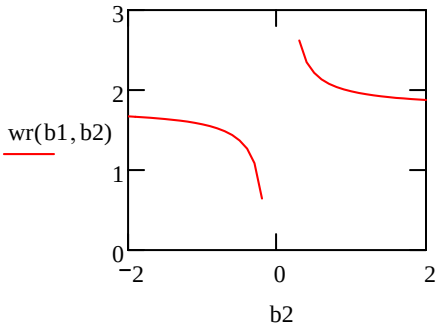

**График зависимостей wp(b1) и wp(b2), Q(b1) и Q(b2) для ПФ**

b1 := −2, −1.9 .. 2  b2 := 0.5




b2 := −2, −1.9 .. 2  b1 := 0.8



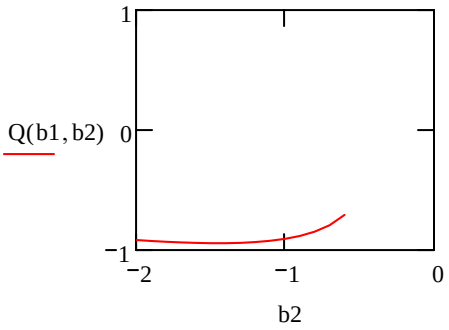
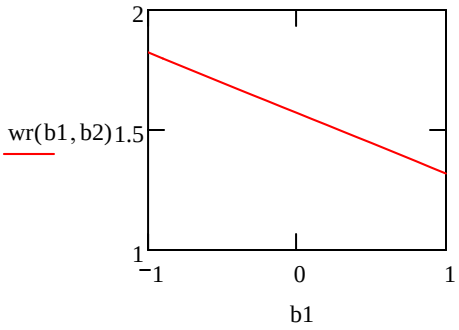
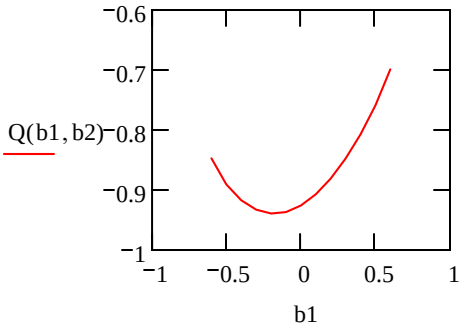





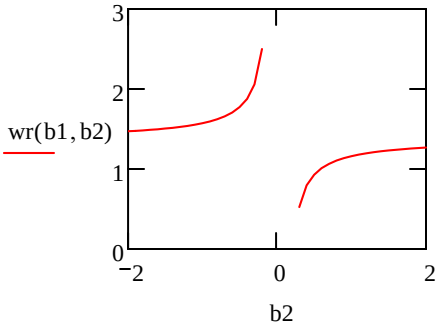

**График зависимостей wp(b1) и wp(b2), Q(b1) и Q(b2) для РФ**

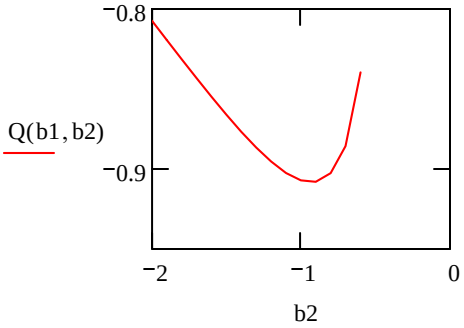
$b1 := -1, -0.9 .. 1 \qquad b2 := -0.5$




$b2 := -2, -1.9 .. 2 \qquad b1 := -0.8$




**Временные характеристики**

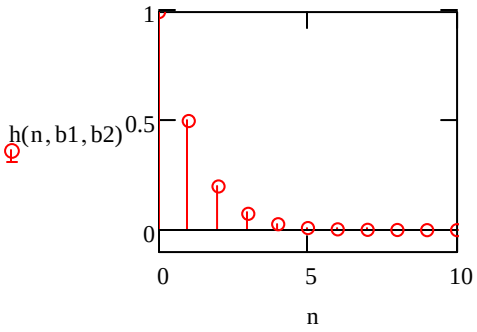
$$p2(b1,b2) := \left(\sqrt{\frac{b1^2 - 4\cdot b2}{4}} + \frac{-b1}{2}\right)$$

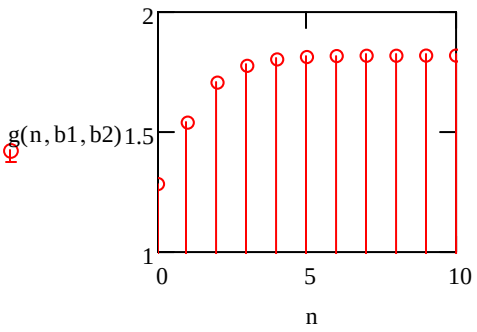
$$p1(b1,b2) := \left(-\sqrt{\frac{b1^2 - 4\cdot b2}{4}} + \frac{-b1}{2}\right)$$

$n := 0, 1 .. 10 \qquad \omega 0 := 1$

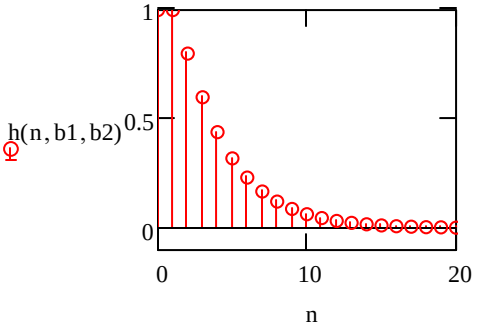
$$h(n,b1,b2) := \frac{p1(b1,b2)^{n+1} - p2(b1,b2)^{n+1}}{p1(b1,b2) - p2(b1,b2)}$$

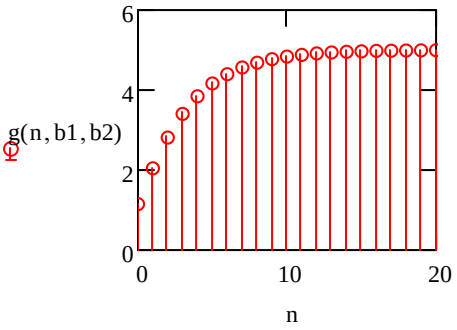
$$g(n,b1,b2) := \frac{1}{1 + b1 + b2} + \frac{1\cdot\left(\frac{p1(b1,b2)^{n+2}}{p1(b1,b2) - p2(b1,b2)} - \frac{p2(b1,b2)^{n+2}}{p2(b1,b2) - 1}\right)}{p1(b1,b2) - p2(b1,b2)}$$




$n := 0, 1 .. 20$ $b1 := -1$ $b2 := 0.2$



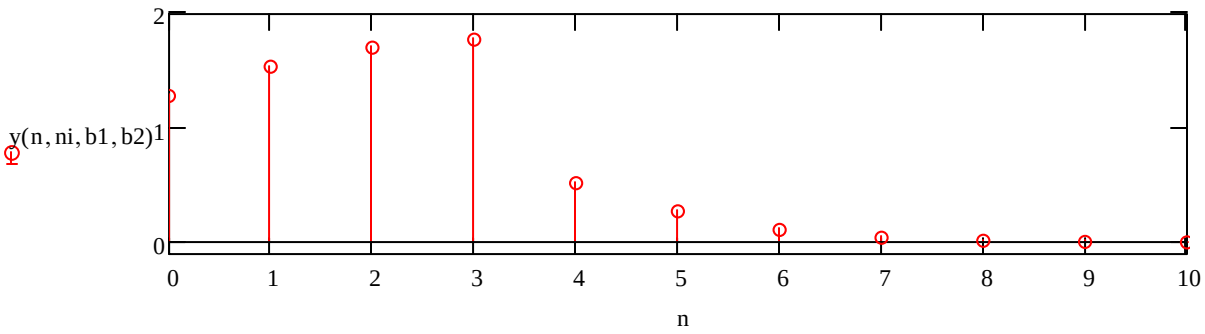




Воздействие прямоугольного импульса

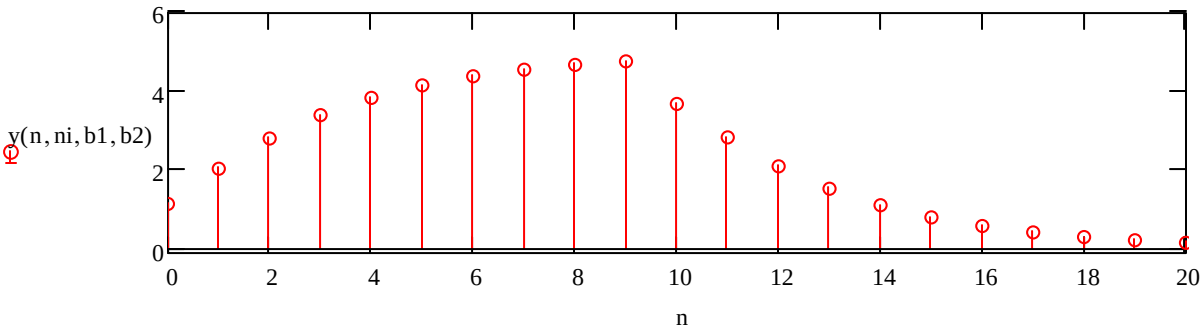
$$l(n) := \begin{cases} 1 & \text{if } n \geq 0 \\ 0 & \text{otherwise} \end{cases}$$

$y(n, ni, b1, b2) := g(n, b1, b2) \cdot l(n) - g(n - ni, b1, b2) \cdot l(n - ni)$

$n := 0, 1 .. 10$ $b1 := -0.5$ $b2 := 0.05$ $ni := 4$




$n := 0, 1 .. 20$ $b1 := -1$ $b2 := 0.2$ $ni := 10$

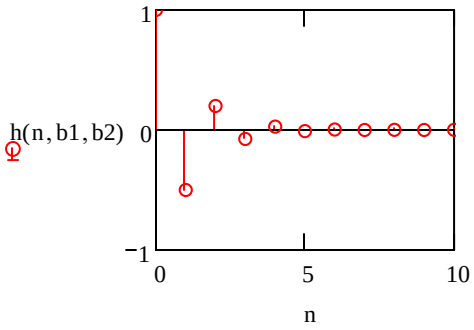


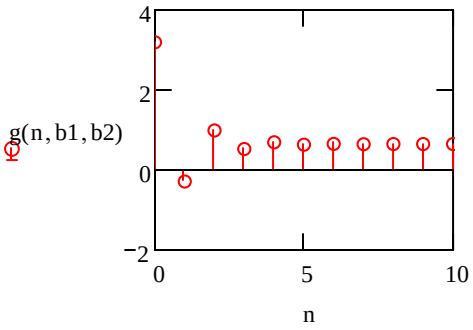




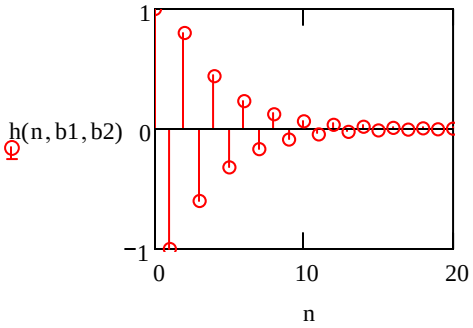

$n := 0, 1 .. 10$

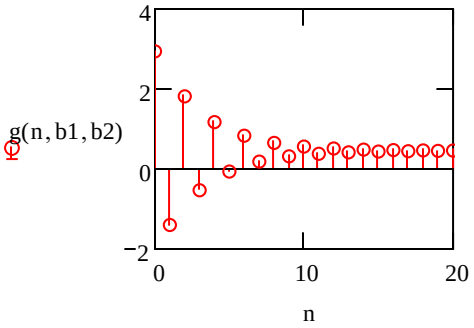
$b1 := -0.5$ $b2 := 0.05$




$n := 0, 1 .. 20$ $b1 := 1$ $b2 := 0.2$



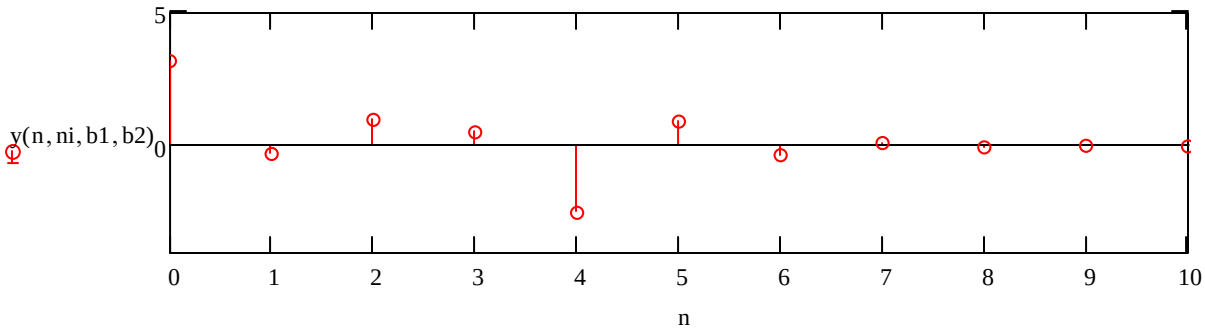




Воздействие прямоугольного импульса

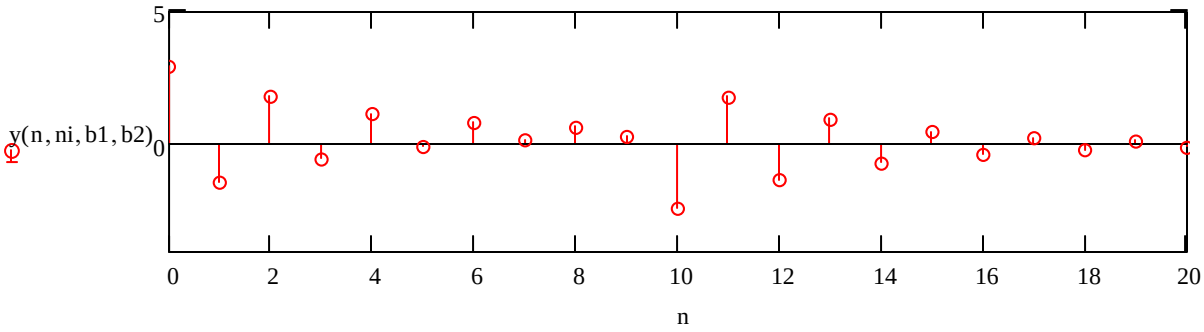
$$l(n) := \begin{cases} 1 & \text{if } n \geq 0 \\ 0 & \text{otherwise} \end{cases}$$

$y(n, ni, b1, b2) := g(n, b1, b2) \cdot l(n) - g(n - ni, b1, b2) \cdot l(n - ni)$

$n := 0, 1 .. 10$ $b1 := 0.5$ $b2 := 0.05$ $ni := 4$




$n := 0, 1 .. 20$ $b1 := 1$ $b2 := 0.2$ $ni := 10$




$$g(n, b1, b2) := \frac{1}{1 + b1 + b2} + \mathrm{Im}\left(\frac{p2(b1, b2)^{n+2}}{p2(b1, b2) - 1}\right)$$

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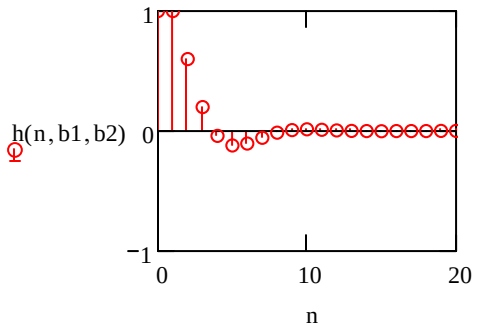
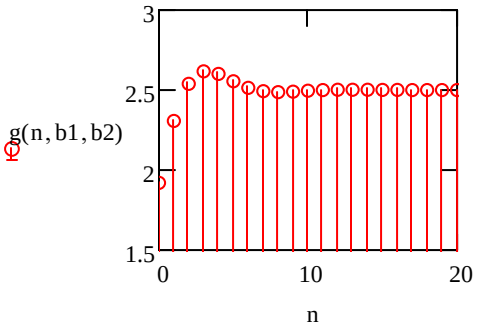
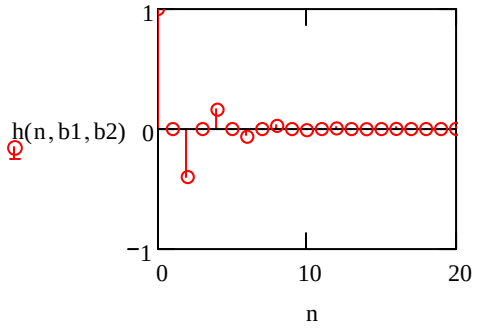
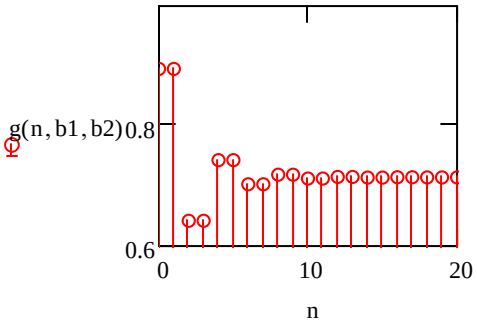
$b1 := -1 \qquad b2 := 0.4 \qquad n := 0,1..20$



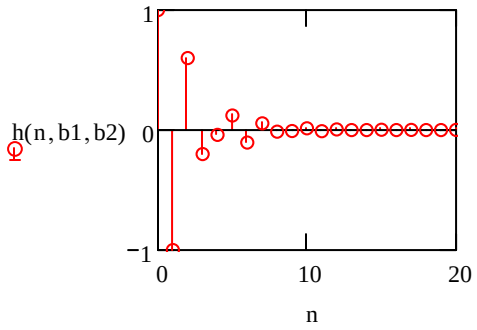



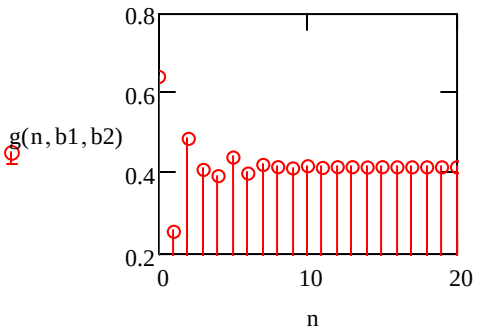

$b1 := 0 \qquad b2 := 0.4 \qquad n := 0,1..20$




$b1 := 1 \qquad b2 := 0.4 \qquad n := 0,1..20$




$$j := \sqrt{-1} \qquad wr(b1,b2) := \operatorname{acos}\left[\frac{-b1\cdot(1+b2)}{4b2}\right]$$

$$y1cx(n,b1,b2) := l(n)\cdot\left[\left[\frac{\exp[j\cdot wr(b1,b2)\cdot(n+2)]}{\exp(j\cdot wr(b1,b2))^2 + b1\cdot\exp(j\cdot wr(b1,b2)) + b2} + \frac{1}{2\cdot j\cdot wr(b1,b2)}\cdot\left(\frac{p1(b1,b2)^{n+2}}{p1(b1,b2) - \exp(j\cdot wr(b1,b2))} - \frac{p2(b1,b2}{p2(b1,b2) - \exp(}\right.\right.$$

$$ycx(n,ni,b1,b2) := -\exp(j\cdot wr(b1,b2)\cdot ni)\cdot y1cx(n-ni,b1,b2) + y1cx(n,b1,b2)$$

$$y2cx(n,ni,b1,b2) := \exp(j\cdot wr(b1,b2)\cdot ni)\cdot y1cx(n-ni,b1,b2)$$

---

**Реакция на воздействие прямоугольного радиоимпульса**

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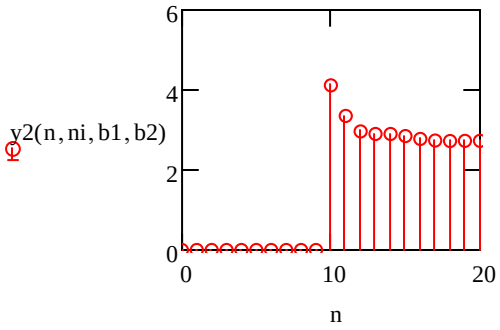
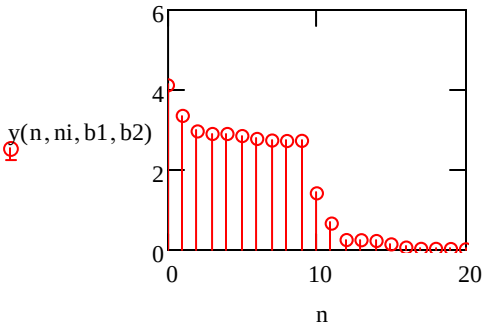
$$y2(n,ni,b1,b2) := \sqrt{Re(y2cx(n,ni,b1,b2))^2 + Im(y2cx(n,ni,b1,b2))^2}$$

$$y(n,ni,b1,b2) := \sqrt{Re(ycx(n,ni,b1,b2))^2 + Im(ycx(n,ni,b1,b2))^2}$$

$n := 0,1..20$ $ni := 10$ $b1 := -1$ $b2 := 0.4$

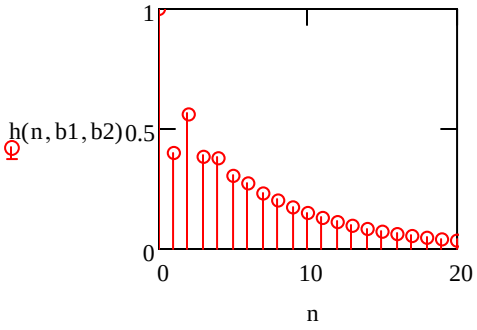


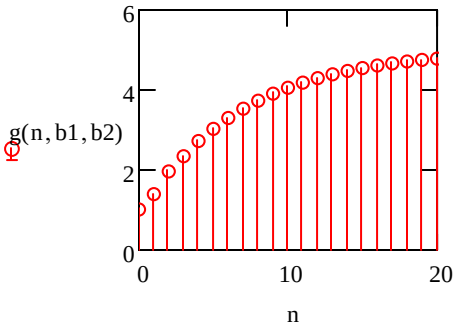




**Режекторный Фильтр**

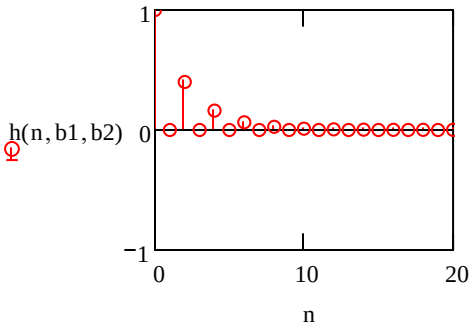
$$g(n,b1,b2) := \frac{1}{1+b1+b2} + \frac{1\cdot\left(\frac{p1(b1,b2)^{n+2}}{p1(b1,b2)-p2(b1,b2)} - \frac{p2(b1,b2)^{n+2}}{p2(b1,b2)-1}\right)}{p1(b1,b2)-p2(b1,b2)}$$

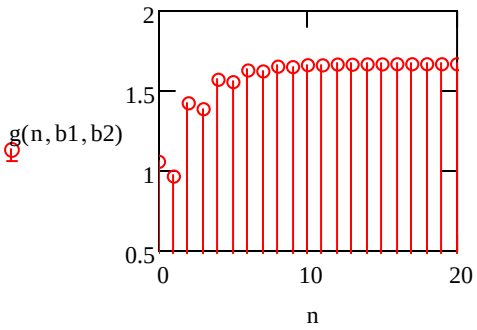
$b1 := -0.4$ $b2 := -0.4$ $n := 0,1..20$



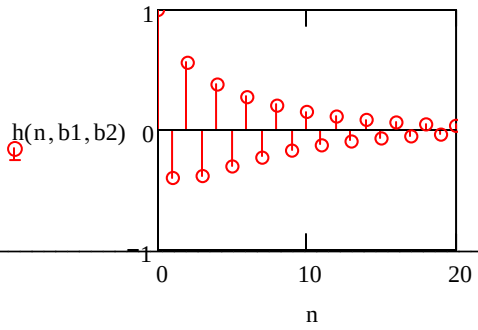

$b1 := 0$ $b2 := -0.4$ $n := 0,1..20$

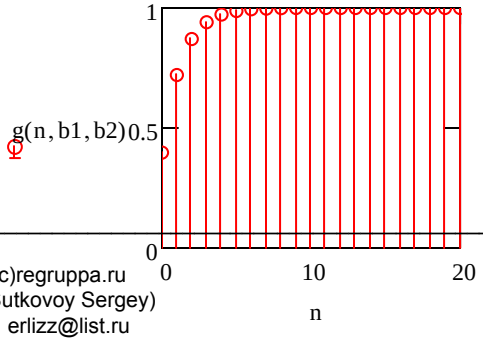



$$g(n,b1,b2) := \frac{1}{1+b1+b2} + 2\cdot Re\left[\frac{p2(b1,b2)^{n+2}}{(p2(b1,b2)-1)\cdot(p2(b1,b2)-p1(b1,b2))}\right]$$

$b1 := 0.4$ $b2 := -0.4$ $n := 0,1..20$



$$j := \sqrt{-1} \qquad wr(b1,b2) := \operatorname{acos}\left[\frac{-b1\cdot(1+b2)}{4b2}\right]$$

$$y1cx(n,b1,b2) := l(n)\cdot\left[\left[\frac{\exp[j\cdot wr(b1,b2)\cdot(n+2)]}{\exp(j\cdot wr(b1,b2))^2 + b1\cdot\exp(j\cdot wr(b1,b2)) + b2} + \frac{1}{2\cdot j\cdot wr(b1,b2)}\cdot\left(\frac{p1(b1,b2)^{n+2}}{p1(b1,b2) - \exp(j\cdot wr(b1,b2))} - \frac{p2(b1,b2}{p2(b1,b2) - \exp(}\right.\right.$$

$$ycx(n,ni,b1,b2) := -\exp(j\cdot wr(b1,b2)\cdot ni)\cdot y1cx(n-ni,b1,b2) + y1cx(n,b1,b2)$$

$$y2cx(n,ni,b1,b2) := \exp(j\cdot wr(b1,b2)\cdot ni)\cdot y1cx(n-ni,b1,b2)$$

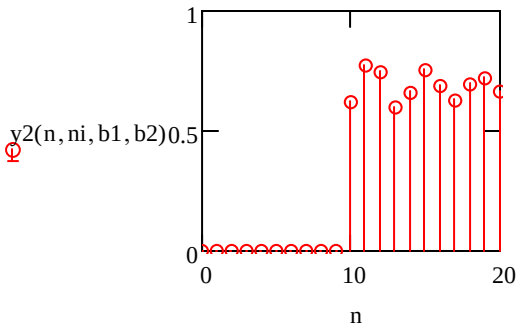
**Реакция на воздействие прямоугольного радиоимпульса**

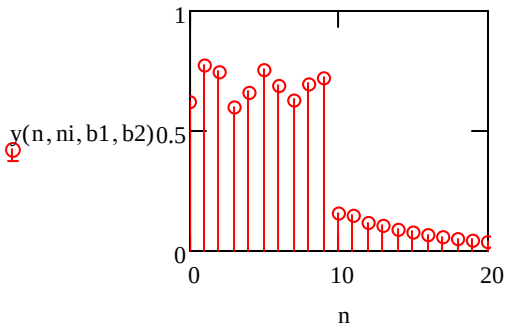
$$y2(n,ni,b1,b2) := \sqrt{Re(y2cx(n,ni,b1,b2))^2 + Im(y2cx(n,ni,b1,b2))^2}$$

$$y(n,ni,b1,b2) := \sqrt{Re(ycx(n,ni,b1,b2))^2 + Im(ycx(n,ni,b1,b2))^2}$$

$b1 := -0.4 \qquad b2 := -0.4$

$n := 0,1..20 \qquad ni := 10$



$$\left(\frac{2)^{n+2}}{(j\cdot wr(b1,b2))}\right)\Bigg]\Bigg]$$

$$\left(\frac{2)^{n+2}}{(j\cdot wr(b1,b2))}\right)\Bigg]\Bigg]$$