

```

clear all;
close all;
syms t x w K

fp = 200;
fg = fp/2; %Hz
wp = 2*pi*fp;
wg = 2*pi*fg;

s = 4/5;
ws = s*wg;

x_sin = sin(ws*t);
X_FT_sin_org = fourier(x_sin);

X_FT_sin = X_FT_sin_org + ... % oryginal widma
    symsum((subs(X_FT_sin_org, w, w - K*wp) + ...% 3 aliasy lewe
    subs(X_FT_sin_org, w, w + K*wp)), K, 1, 3); % 3 aliasy prawe

FILT_FT = rectangularPulse(-wg, wg, w); % filtr rekonstruujący
x_sin_rek = ifourier(X_FT_sin * FILT_FT); % odwr. tarnsf. Fouriera

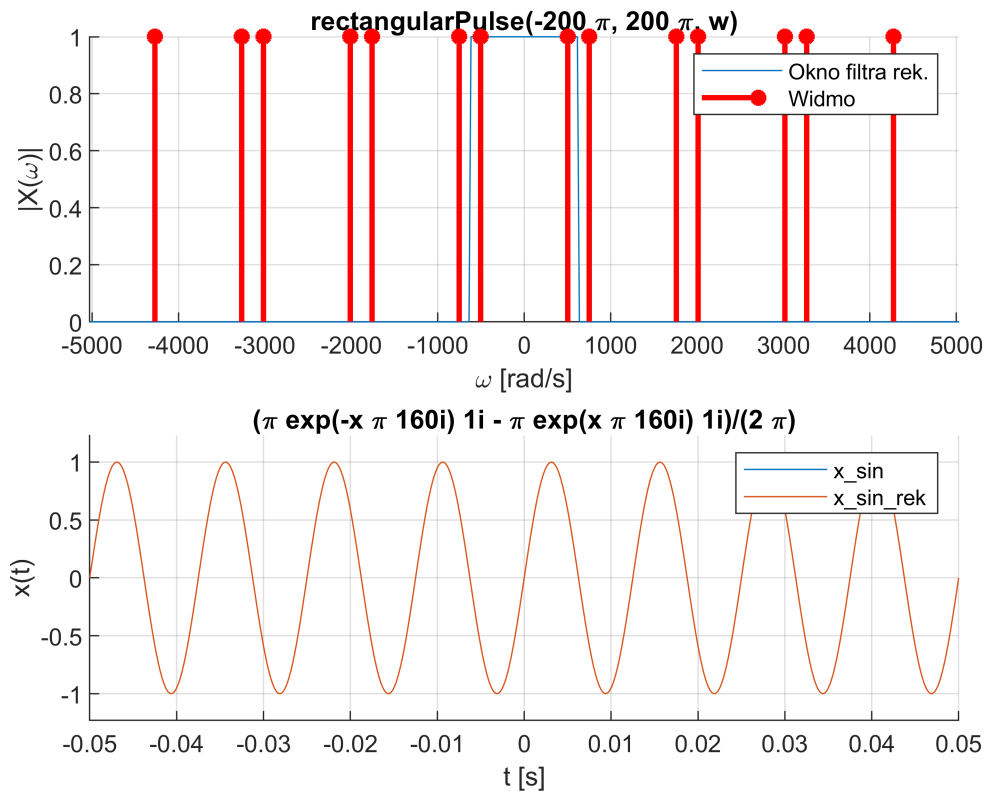
BND_t = [-10/fp; 10/fp];
%t_SMP = [BND_t(1):1/(10*fp):BND_t(2)];
BND_w = [-4*wp; 4*wp];
w_SMP = [BND_w(1):wp/10:BND_w(2)];

figure; subplot(2,1,1); hold on; grid on;
ezplot(FILT_FT, BND_w); %okno filtru rek.
%ezplot(X_FT_sin, BND_w)

v_num = abs(double(subs(X_FT_sin, w, w_SMP)));
n = find(abs(v_num) == Inf);
stem(w_SMP(n), sign(v_num(n)), 'r*', 'LineWidth', 2);
xlabel('\omega [rad/s]'); ylabel('|X(\omega)|')
legend('Okno filtra rek.', 'Widmo');

subplot(2,1,2); hold on; grid on;
ezplot(x_sin, BND_t); % syg. próbkowany
ezplot(x_sin_rek, BND_t) % syg. odtworzony
xlabel('t [s]'); ylabel('x(t)')
legend('x\_sin', 'x\_sin\_rek');

```



% Zadanie 2

```
x_sin = sin(ws*t);
X_FT_sin_org = fourier(x_sin);

X_FT_sin = X_FT_sin_org + ... % oryginal widma
    symsum((subs(X_FT_sin_org, w, w - K*wp ) + ...% 3 aliasy lewe
    subs(X_FT_sin_org, w, w + K*wp)), K , 1, 3); % 3 aliasy prawe

FILT_FT = rectangularPulse(-wg, wg, w); % filtr rekonstruuujacy
x_sin_rek = ifourier(X_FT_sin * FILT_FT); % odwr. tarnsf. Fouriera

BND_t = [-10/fp; 10/fp];
%t_SMP = [BND_t(1):1/(10*fp):BND_t(2) ];
BND_w = [-4*wp; 4*wp];
w_SMP = [BND_w(1):wp/10:BND_w(2)];

figure; subplot(2,1,1); hold on; grid on;
ezplot(FILT_FT, BND_w); %okno filtru rek.
%ezplot(X_FT_sin, BND_w)

v_num = abs(double(subs(X_FT_sin, w, w_SMP)));
n = find(abs(v_num) == Inf);
stem(w_SMP(n), sign(v_num(n)), 'r*', 'LineWidth', 2);
xlabel('\omega [rad/s]'); ylabel('|X(\omega)|')
legend('Okno filtra rek.', 'Widmo');

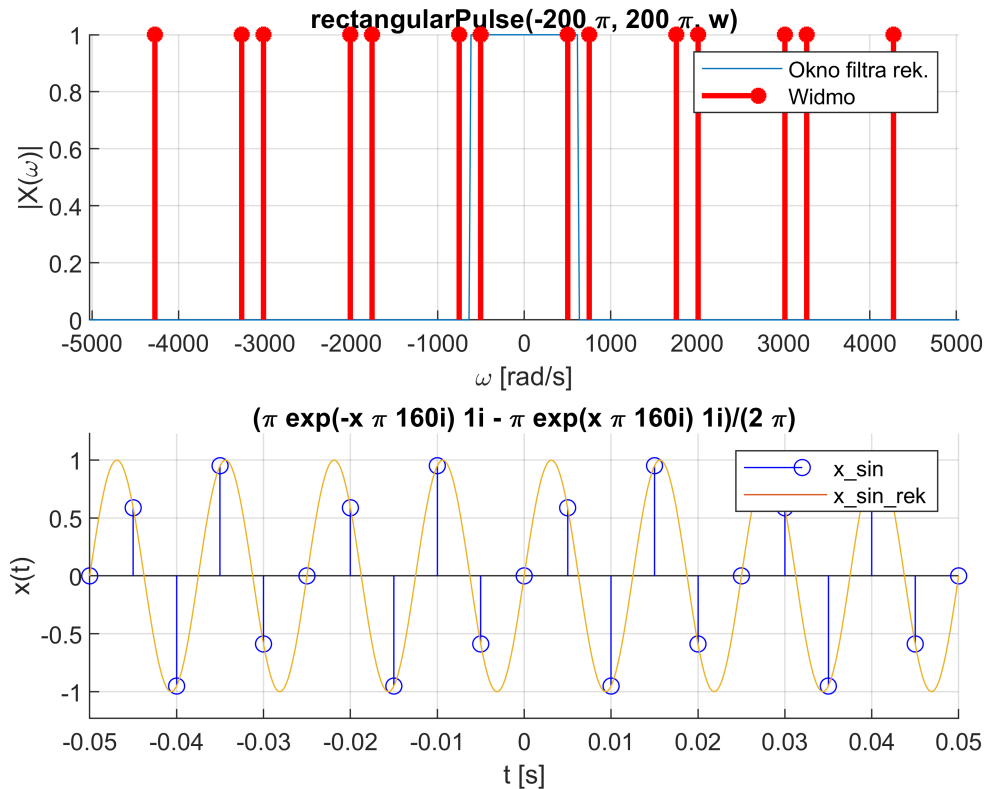
wezly = BND_t(1) : 1/fp : BND_t(2);
```

```

wezly_val = subs(x_sin_rek, x, wezly);

subplot(2,1,2); hold on; grid on;
stem(wezly, wezly_val, 'b');
ezplot(x_sin, BND_t); % syg. próbkowany
ezplot(x_sin_rek, BND_t) % syg. odtworzony
xlabel('t [s]'); ylabel('x(t)')
legend('x\_sin', 'x\_sin\_rek');

```



```

% Zadanie 3
% a)
s = 1/5;
ws = s*wg;

x_sin = sin(ws*t);
X_FT_sin_org = fourier(x_sin);

X_FT_sin = X_FT_sin_org + ... % oryginalny widma
    symsum((subs(X_FT_sin_org, w, w - K*wp ) + ...% 3 aliasy lewe
    subs(X_FT_sin_org, w, w + K*wp)), K , 1, 3); % 3 aliasy prawe

FILT_FT = rectangularPulse(-wg, wg, w); % filtr rekonstruujący
x_sin_rek = ifourier(X_FT_sin * FILT_FT); % odwr. transf. Fouriera

BND_t = [-10/fp; 10/fp];
%t_SMP = [BND_t(1):1/(10*fp):BND_t(2) ];

```

```

BND_w = [-4*wp;4*wp];
w_SMP = [BND_w(1):wp/10:BND_w(2)];

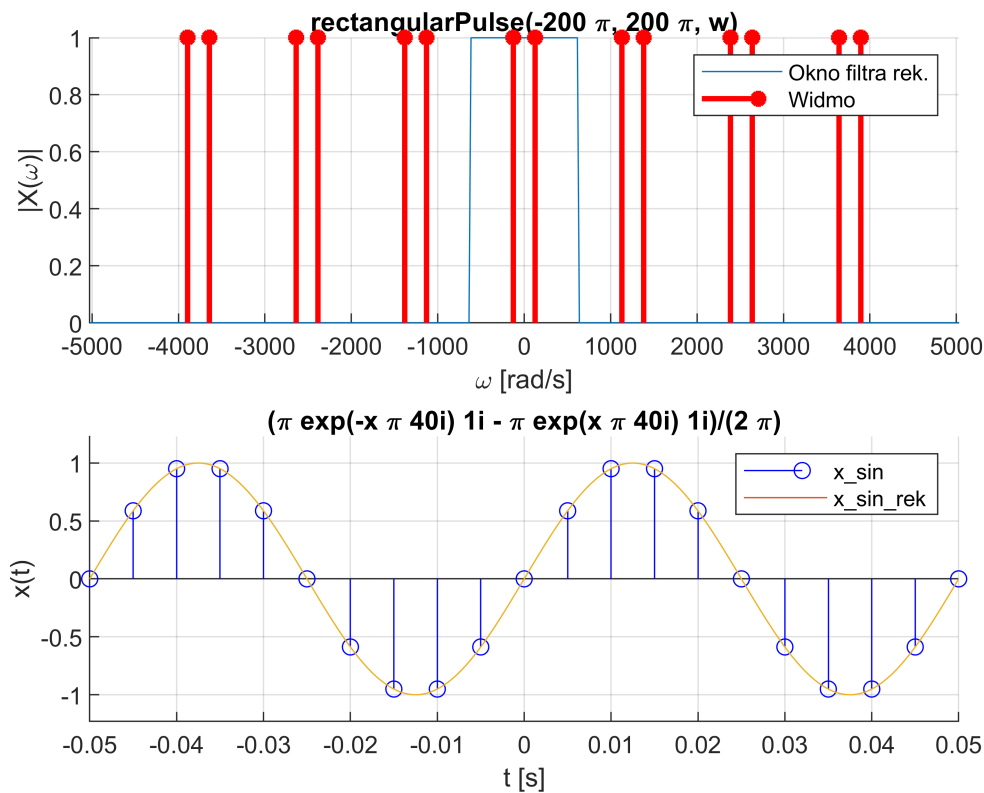
figure; subplot(2,1,1); hold on; grid on;
ezplot(FILT_FT,BND_w); %okno filtru rek.
%ezplot(X_FT_sin,BND_w)

v_num = abs(double(subs(X_FT_sin, w, w_SMP)));
n = find(abs(v_num) == Inf);
stem(w_SMP(n),sign(v_num(n)), 'r*', 'LineWidth', 2);
xlabel('\omega [rad/s]'); ylabel('|X(\omega)|')
legend('Okno filtra rek.', 'Widmo');

wezly = BND_t(1) : 1/fp : BND_t(2);
wezly_val = subs(x_sin_rek, x, wezly);

subplot(2,1,2); hold on; grid on;
stem(wezly, wezly_val, 'b');
ezplot(x_sin, BND_t); % syg. próbkowany
ezplot(x_sin_rek, BND_t) % syg. odtworzony
xlabel('t [s]'); ylabel('x(t)')
legend('x\_sin', 'x\_sin\_rek');

```



```

% Zadanie 3
% b)
s = 6/5;
ws = s*wg;

```

```

x_sin = sin(ws*t);
X_FT_sin_org = fourier(x_sin);

X_FT_sin = X_FT_sin_org + ... % oryginal widma
    symsum((subs(X_FT_sin_org, w, w - K*wp ) + ...% 3 aliasy lewe
    subs(X_FT_sin_org, w, w + K*wp)), K , 1, 3); % 3 aliasy prawe

FILT_FT = rectangularPulse(-wg, wg, w); % filtr rekonstruujący
x_sin_rek = ifourier(X_FT_sin * FILT_FT); % odwr. transf. Fouriera

BND_t = [-10/fp; 10/fp];
%t_SMP = [BND_t(1):1/(10*fp):BND_t(2) ];
BND_w = [-4*wp; 4*wp];
w_SMP = [BND_w(1):wp/10:BND_w(2)];

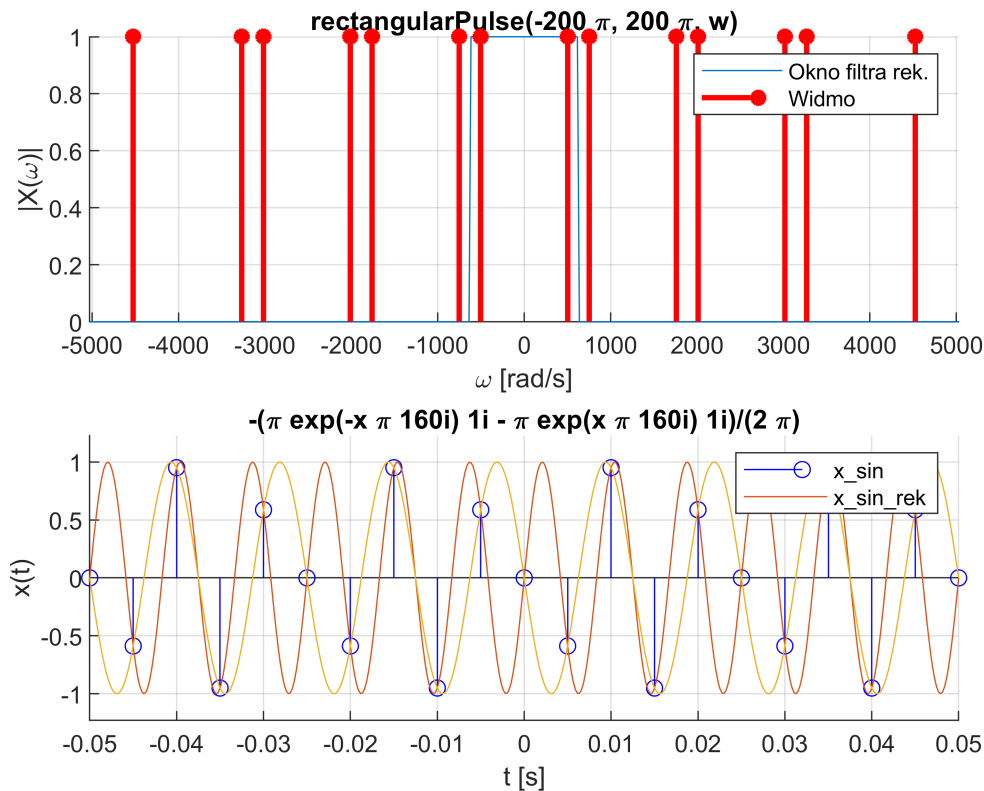
figure; subplot(2,1,1); hold on; grid on;
ezplot(FILT_FT, BND_w); %okno filtru rek.
%ezplot(X_FT_sin, BND_w)

v_num = abs(double(subs(X_FT_sin, w, w_SMP)));
n = find(abs(v_num) == Inf);
stem(w_SMP(n), sign(v_num(n)), 'r*', 'LineWidth', 2);
xlabel('\omega [rad/s]'); ylabel('|X(\omega)|')
legend('Okno filtra rek.', 'Widmo');

wezly = BND_t(1) : 1/fp : BND_t(2);
wezly_val = subs(x_sin_rek, x, wezly);

subplot(2,1,2); hold on; grid on;
stem(wezly, wezly_val, 'b');
ezplot(x_sin, BND_t); % syg. próbkowany
ezplot(x_sin_rek, BND_t) % syg. odtworzony
xlabel('t [s]'); ylabel('x(t)')
legend('x\_sin', 'x\_sin\_rek');

```



```
% Zadanie 3
% c)
s = 11/5;
ws = s*wg;

x_sin = sin(ws*t);
X_FT_sin_org = fourier(x_sin);

X_FT_sin = X_FT_sin_org + ... % oryginalne widmo
    symsum((subs(X_FT_sin_org, w, w - K*wp) + ...% 3 aliasy lewe
    subs(X_FT_sin_org, w, w + K*wp)), K, 1, 3); % 3 aliasy prawe

FILT_FT = rectangularPulse(-wg, wg, w); % filtr rekonstruujący
x_sin_rek = ifourier(X_FT_sin * FILT_FT); % odwr. transf. Fouriera

BND_t = [-10/fp; 10/fp];
%t_SMP = [BND_t(1):1/(10*fp):BND_t(2)];
BND_w = [-4*wp; 4*wp];
w_SMP = [BND_w(1):wp/10:BND_w(2)];

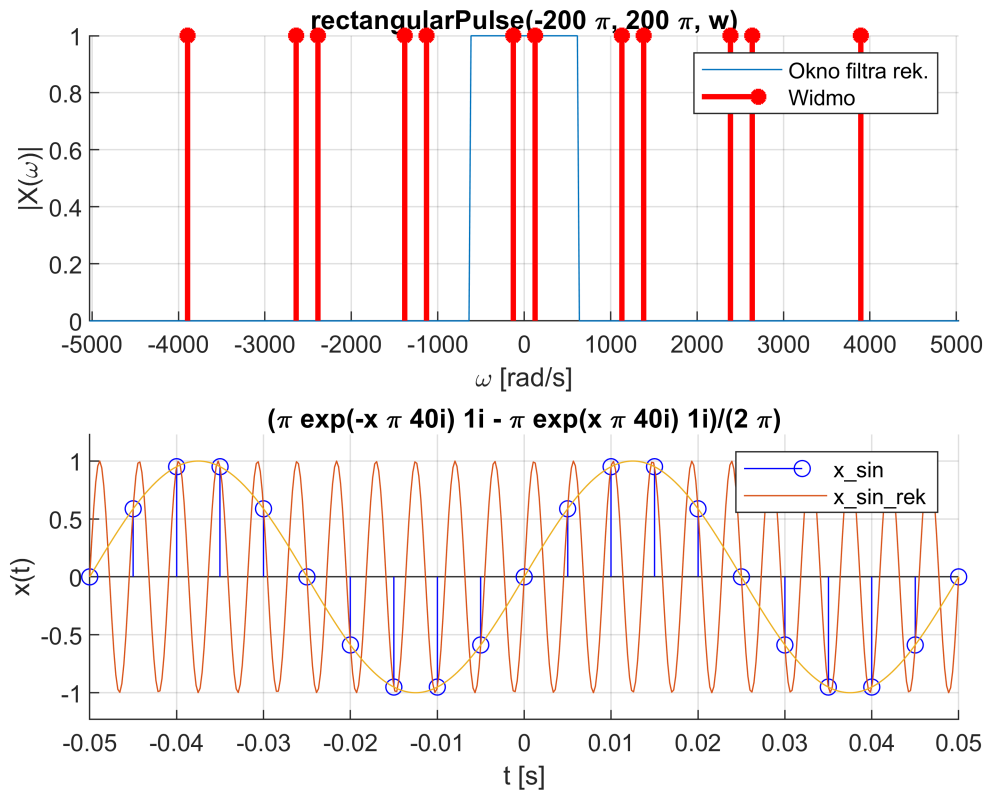
figure; subplot(2,1,1); hold on; grid on;
ezplot(FILT_FT, BND_w); %okno filtru rek.
%ezplot(X_FT_sin, BND_w)

v_num = abs(double(subs(X_FT_sin, w, w_SMP)));
n = find(abs(v_num) == Inf);
stem(w_SMP(n), sign(v_num(n)), 'r*', 'LineWidth', 2);
```

```
xlabel('\omega [rad/s]'); ylabel('|X(\omega)|')
legend('Okno filtra rek.', 'Widmo');
```

```
wezly = BND_t(1) : 1/fp : BND_t(2);
wezly_val = subs(x_sin_rek, x, wezly);
```

```
subplot(2,1,2); hold on; grid on;
stem(wezly, wezly_val, 'b');
ezplot(x_sin, BND_t); % syg. próbkowany
ezplot(x_sin_rek, BND_t) % syg. odtworzony
xlabel('t [s]'); ylabel('x(t)')
legend('x\_sin', 'x\_sin\_rek');
```



```
% Zadanie 3
```

```
% d)
```

```
s = 16/5;
```

```
ws = s*wg;
```

```
x_sin = sin(ws*t);
```

```
X_FT_sin_org = fourier(x_sin);
```

```
X_FT_sin = X_FT_sin_org + ... % oryginal widma
```

```
symsum((subs(X_FT_sin_org, w, w - K*wp ) + ...% 3 aliasy lewe
subs(X_FT_sin_org, w, w + K*wp)), K , 1, 3); % 3 aliasy prawe
```

```
FILT_FT = rectangularPulse(-wg, wg, w); % filtr rekonstruujący
```

```
x_sin_rek = ifourier(X_FT_sin*FILT_FT); % odwr. tarnsf. Fouriera
```

```

BND_t = [-10/fp;10/fp];
%t_SMP = [BND_t(1):1/(10*fp):BND_t(2) ];
BND_w = [-4*wp;4*wp];
w_SMP = [BND_w(1):wp/10:BND_w(2)];

figure; subplot(2,1,1); hold on; grid on;
ezplot(FILT_FT,BND_w); %okno filtru rek.
%ezplot(X_FT_sin,BND_w)

v_num = abs(double(subs(X_FT_sin, w, w_SMP)));
n = find(abs(v_num) == Inf);
stem(w_SMP(n),sign(v_num(n)), 'r*', 'LineWidth', 2);
xlabel('\omega [rad/s]'); ylabel('|X(\omega)|')
legend('Okno filtra rek.', 'Widmo');

wezly = BND_t(1) : 1/fp : BND_t(2);
wezly_val = subs(x_sin_rek, x, wezly);

subplot(2,1,2); hold on; grid on;
stem(wezly, wezly_val, 'b');
ezplot(x_sin, BND_t); % syg. próbkowany
ezplot(x_sin_rek, BND_t) % syg. odtworzony
xlabel('t [s]'); ylabel('x(t)')
legend('x\sin', 'x\sin\rek');

```

```

% Zadanie 3
% e)
s = 4/5;
ws = s*wg;

x_sin = sin(ws*t);
X_FT_sin_org = fourier(x_sin);

X_FT_sin = X_FT_sin_org + ... % oryginal widma
    symsum((subs(X_FT_sin_org, w, w - K*wp ) + ...% 3 aliasy lewe
    subs(X_FT_sin_org, w, w + K*wp)), K , 1, 3); % 3 aliasy prawe

FILT_FT = rectangularPulse(-wg, wg, w); % filtr rekonstruujący
x_sin_rek = ifourier(X_FT_sin*FILT_FT); % odwr. tarnsf. Fouriera

BND_t = [-10/fp;10/fp];
%t_SMP = [BND_t(1):1/(10*fp):BND_t(2) ];
BND_w = [-4*wp;4*wp];
w_SMP = [BND_w(1):wp/10:BND_w(2)];

figure; subplot(2,1,1); hold on; grid on;
ezplot(FILT_FT,BND_w); %okno filtru rek.
%ezplot(X_FT_sin,BND_w)

v_num = abs(double(subs(X_FT_sin, w, w_SMP)));
n = find(abs(v_num) == Inf);
stem(w_SMP(n),sign(v_num(n)), 'r*', 'LineWidth', 2);

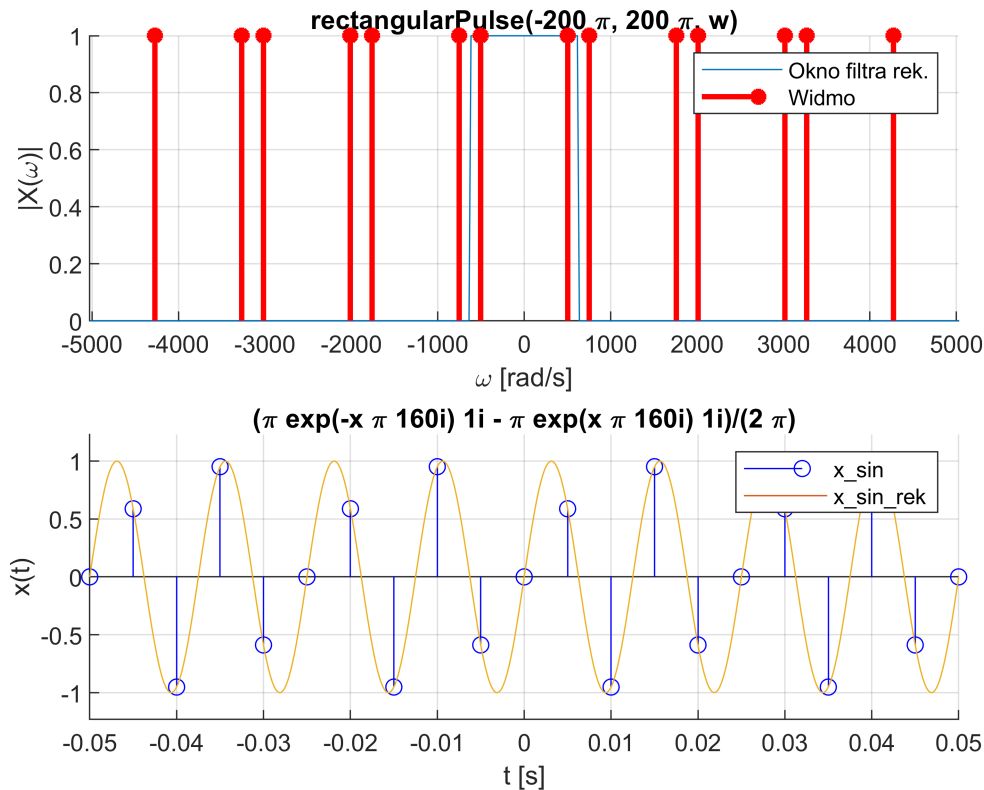
```



```
xlabel('\omega [rad/s]'); ylabel('|X(\omega)|')
legend('Okno filtra rek.', 'Widmo');
```

```
wezly = BND_t(1) : 1/fp : BND_t(2);
wezly_val = subs(x_sin_rek, x, wezly);
```

```
subplot(2,1,2); hold on; grid on;
stem(wezly, wezly_val, 'b');
ezplot(x_sin, BND_t); % syg. próbkowany
ezplot(x_sin_rek, BND_t) % syg. odtworzony
xlabel('t [s]'); ylabel('x(t)')
legend('x\_sin', 'x\_sin\_rek');
```



```
% Zadanie 3
```

```
% f)
```

```
s = 9/5;
```

```
ws = s*wg;
```

```
x_sin = sin(ws*t);
```

```
X_FT_sin_org = fourier(x_sin);
```

```
X_FT_sin = X_FT_sin_org + ... % oryginal widma
```

```
symsum((subs(X_FT_sin_org, w, w - K*wp ) + ...% 3 aliasy lewe
subs(X_FT_sin_org, w, w + K*wp)), K , 1, 3); % 3 aliasy prawe
```

```
FILT_FT = rectangularPulse(-wg, wg, w); % filtr rekonstruujący
```

```
x_sin_rek = ifourier(X_FT_sin*FILT_FT); % odwr. tarnsf. Fouriera
```

```

BND_t = [-10/fp;10/fp];
%t_SMP = [BND_t(1):1/(10*fp):BND_t(2) ];
BND_w = [-4*wp;4*wp];
w_SMP = [BND_w(1):wp/10:BND_w(2)];

figure; subplot(2,1,1); hold on; grid on;
ezplot(FILT_FT,BND_w); %okno filtru rek.
%ezplot(X_FT_sin,BND_w)

v_num = abs(double(subs(X_FT_sin, w, w_SMP)));
n = find(abs(v_num) == Inf);
stem(w_SMP(n),sign(v_num(n)), 'r*', 'LineWidth', 2);
xlabel('\omega [rad/s]'); ylabel('|X(\omega)|')
legend('Okno filtra rek.', 'Widmo');

wezly = BND_t(1) : 1/fp : BND_t(2);
wezly_val = subs(x_sin_rek, x, wezly);

subplot(2,1,2); hold on; grid on;
stem(wezly, wezly_val, 'b');
ezplot(x_sin, BND_t); % syg. próbkowany
ezplot(x_sin_rek, BND_t) % syg. odtworzony
xlabel('t [s]'); ylabel('x(t)')
legend('x\sin', 'x\sin\rek');

```

```

% Zadanie 3
% g)
s = 14/5;
ws = s*wg;

x_sin = sin(ws*t);
X_FT_sin_org = fourier(x_sin);

X_FT_sin = X_FT_sin_org + ... % oryginal widma
    symsum((subs(X_FT_sin_org, w, w - K*wp ) + ...% 3 aliasy lewe
    subs(X_FT_sin_org, w, w + K*wp)), K , 1, 3); % 3 aliasy prawe

FILT_FT = rectangularPulse(-wg,wg,w); % filtr rekonstruujący
x_sin_rek = ifourier(X_FT_sin*FILT_FT); % odwr. tarnsf. Fouriera

BND_t = [-10/fp;10/fp];
%t_SMP = [BND_t(1):1/(10*fp):BND_t(2) ];
BND_w = [-4*wp;4*wp];
w_SMP = [BND_w(1):wp/10:BND_w(2)];

figure; subplot(2,1,1); hold on; grid on;
ezplot(FILT_FT,BND_w); %okno filtru rek.
%ezplot(X_FT_sin,BND_w)

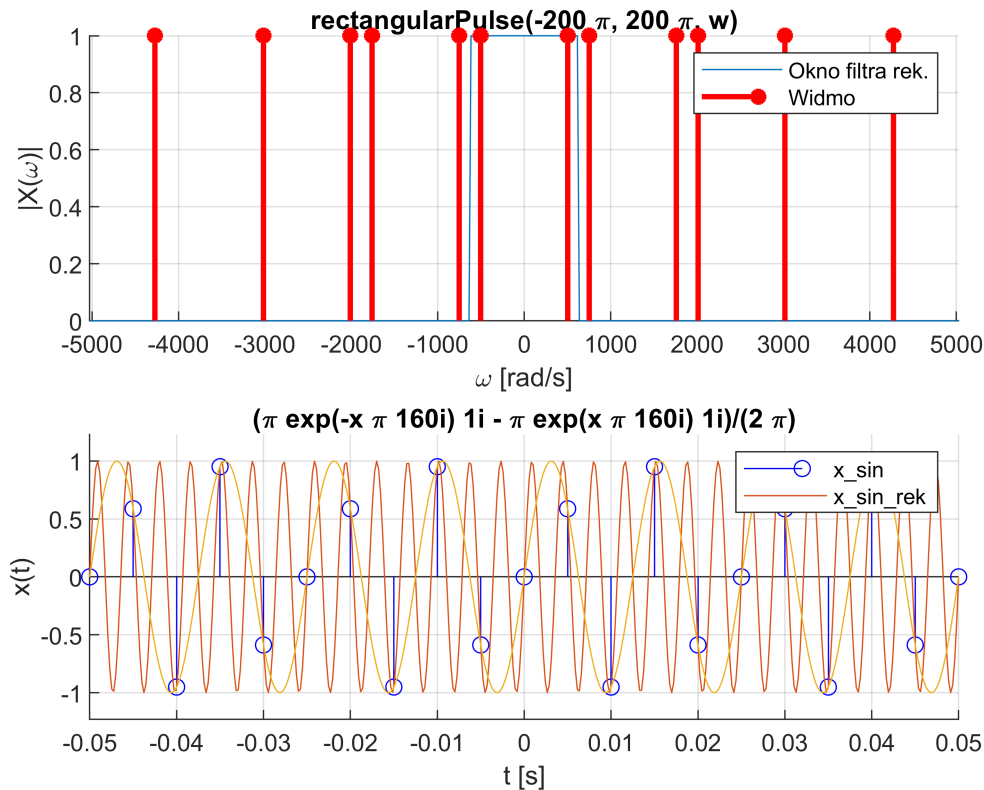
v_num = abs(double(subs(X_FT_sin, w, w_SMP)));
n = find(abs(v_num) == Inf);
stem(w_SMP(n),sign(v_num(n)), 'r*', 'LineWidth', 2);

```

```
xlabel('\omega [rad/s]'); ylabel('|X(\omega)|')
legend('Okno filtra rek.', 'Widmo');
```

```
wezly = BND_t(1) : 1/fp : BND_t(2);
wezly_val = subs(x_sin_rek, x, wezly);
```

```
subplot(2,1,2); hold on; grid on;
stem(wezly, wezly_val, 'b');
ezplot(x_sin, BND_t); % syg. próbkowany
ezplot(x_sin_rek, BND_t) % syg. odtworzony
xlabel('t [s]'); ylabel('x(t)')
legend('x\_sin', 'x\_sin\_rek');
```



```
% zadanie 4
%a)
fp = 200;
fg = fp/2; %Hz
wp = 2*pi*fp;
wg = 2*pi*fg;

s = 1/5;
ws = s*wg;

x_sin = ifourier(triangularPulse(-ws, ws, w));
X_FT_sin_org = triangularPulse(-ws, ws, w);

X_FT_sin = X_FT_sin_org + ... % oryginal widma
```

```

symsum((subs(X_FT_sin_org, w, w - K*wp ) + ...% 3 aliasy lewe
subs(X_FT_sin_org, w, w + K*wp)), K , 1, 3); % 3 aliasy prawe

FILT_FT = rectangularPulse(-wg,wg,w); % filtr rekonstruujący
x_sin_rek = ifourier(X_FT_sin*FILT_FT); % odwr. tarnsf. Fouriera

BND_t = [-10/fp;10/fp];
%t_SMP = [BND_t(1):1/(10*fp):BND_t(2) ];
BND_w = [-4*wp;4*wp];
w_SMP = [BND_w(1):wp/10:BND_w(2)];

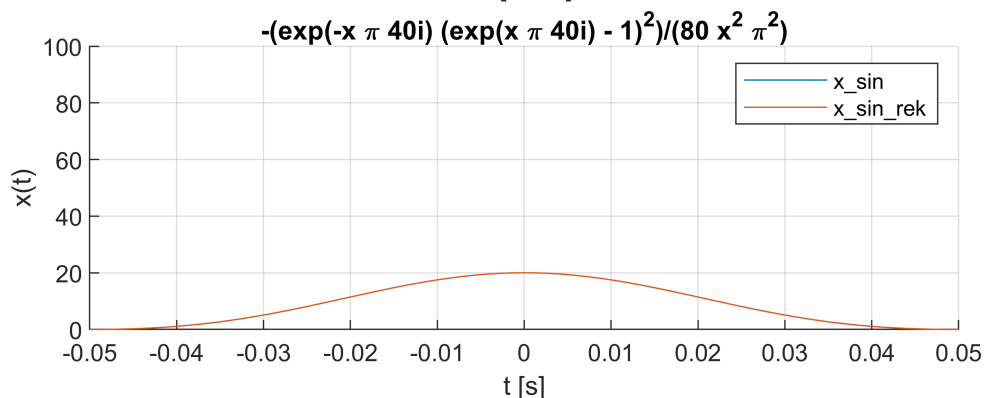
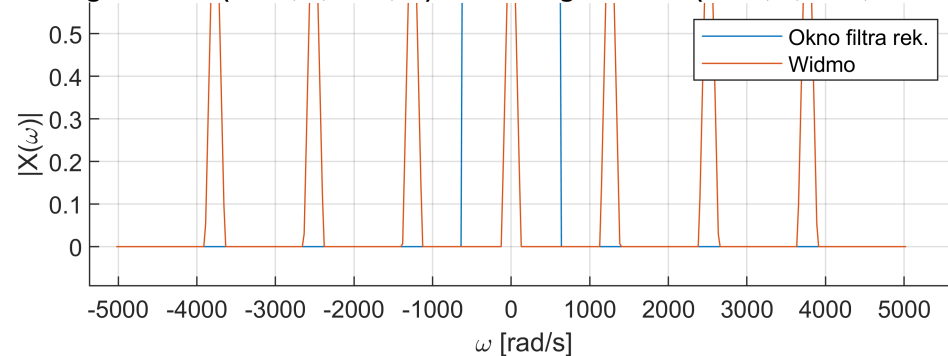
figure; subplot(2,1,1); hold on; grid on;
ezplot(FILT_FT,BND_w); %okno filtru rek.
ezplot(X_FT_sin,BND_w)

v_num = abs(double(subs(X_FT_sin, w, w_SMP)));
n = find(abs(v_num) == Inf);
stem(w_SMP(n),sign(v_num(n)), 'r*', 'LineWidth', 2);
xlabel('\omega [rad/s]'); ylabel('|X(\omega)|')
legend('Okno filtra rek.', 'Widmo');

subplot(2,1,2); hold on; grid on;
ezplot(x_sin, BND_t); % syg. próbkowany
ezplot(x_sin_rek, BND_t) % syg. odtworzony
ylim([0 100])
xlabel('t [s]'); ylabel('x(t)')
legend('x_sin', 'x_sin_rek');

```

triangularPulse(-40 π , 0, 40 π , w) +...+ triangularPulse(-40 π , 0, 40 π , w + 1200 π)



```

% Zadanie 4
%b)
s = 6/5;
ws = s*wg;

x_sin = ifourier(triangularPulse(-ws, ws, w));
X_FT_sin_org = triangularPulse(-ws, ws, w);

X_FT_sin = X_FT_sin_org + ... % oryginal widma
    symsum((subs(X_FT_sin_org, w, w - K*wp ) + ...% 3 aliasy lewe
    subs(X_FT_sin_org, w, w + K*wp)), K , 1, 3); % 3 aliasy prawe

FILT_FT = rectangularPulse(-wg, wg, w); % filtr rekonstruujący
x_sin_rek = ifourier(X_FT_sin * FILT_FT); % odwr. transf. Fouriera

BND_t = [-10/fp; 10/fp];
%t_SMP = [BND_t(1):1/(10*fp):BND_t(2) ];
BND_w = [-4*wp; 4*wp];
w_SMP = [BND_w(1):wp/10:BND_w(2)];

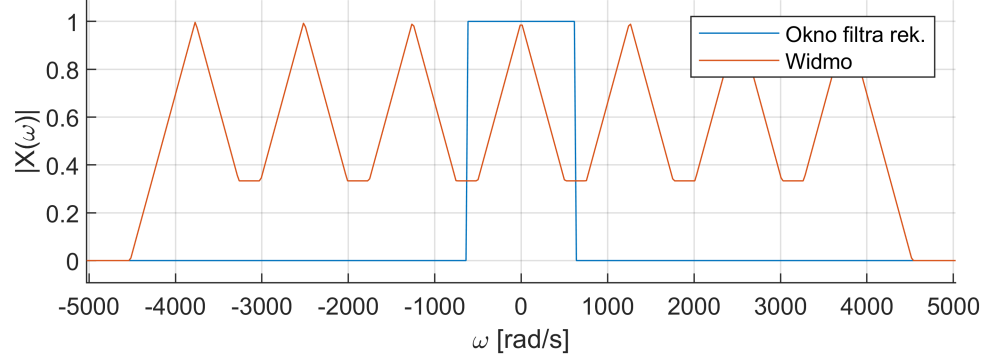
figure; subplot(2,1,1); hold on; grid on;
ezplot(FILT_FT, BND_w); % okno filtru rek.
ezplot(X_FT_sin, BND_w);

v_num = abs(double(subs(X_FT_sin, w, w_SMP)));
n = find(abs(v_num) == Inf);
stem(w_SMP(n), sign(v_num(n)), 'r*', 'LineWidth', 2);
xlabel('\omega [rad/s]'); ylabel('|X(\omega)|')
legend('Okno filtra rek.', 'Widmo');

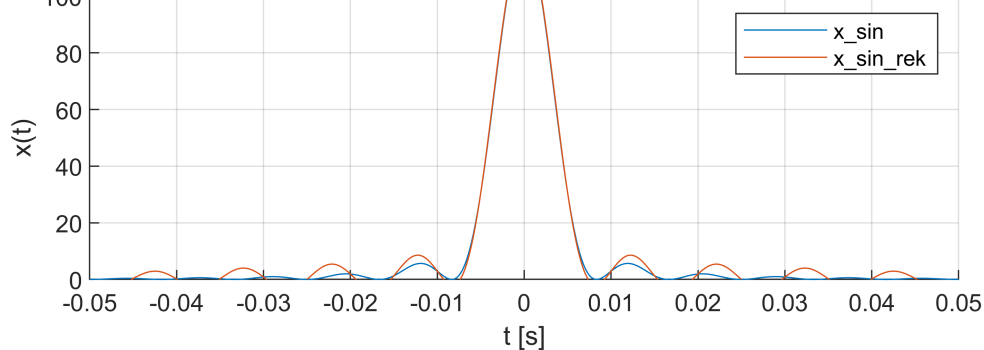
subplot(2,1,2); hold on; grid on;
ezplot(x_sin, BND_t); % syg. próbkowany
ezplot(x_sin_rek, BND_t) % syg. odtworzony
ylim([0 100])
xlabel('t [s]'); ylabel('x(t)')
legend('x_sin', 'x_sin_rek');

```

triangularPulse(-240 π , 0, 240 π , w) + ... + triangularPulse(-240 π , 0, 240 π , w + 1200 π)



$-(\exp(-x \pi 160i) + \exp(x \pi 160i) - x \pi \exp(-x \pi 200i) 80i + x \pi \exp(x \pi 200i) 80i - 2)/(480 x^2 \pi$



% Zadanie 4

%c)

s = 11/5;

ws = s*wg;

x_sin = ifourier(triangularPulse(-ws, ws, w));

X_FT_sin_org = triangularPulse(-ws, ws, w);

X_FT_sin = X_FT_sin_org + ... % oryginalne widmo

symsum((subs(X_FT_sin_org, w, w - K*wp) + ...% 3 aliasy lewe

subs(X_FT_sin_org, w, w + K*wp)), K, 1, 3); % 3 aliasy prawe

FILT_FT = rectangularPulse(-wg, wg, w); % filtr rekonstrukcyjny

x_sin_rek = ifourier(X_FT_sin * FILT_FT); % odw. transf. Fouriera

BND_t = [-10/fp; 10/fp];

%t_SMP = [BND_t(1):1/(10*fp):BND_t(2)];

BND_w = [-4*wp; 4*wp];

w_SMP = [BND_w(1):wp/10:BND_w(2)];

figure; subplot(2,1,1); hold on; grid on;

ezplot(FILT_FT, BND_w); %okno filtru rek.

ezplot(X_FT_sin, BND_w)

v_num = abs(double(subs(X_FT_sin, w, w_SMP)));

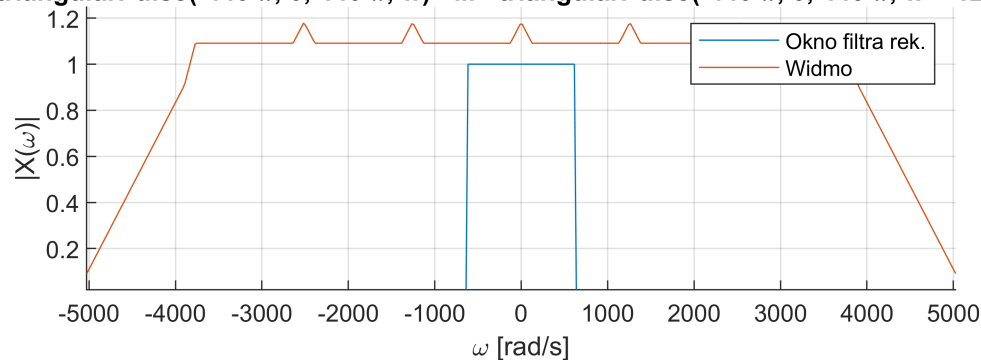
n = find(abs(v_num) == Inf);

stem(w_SMP(n), sign(v_num(n)), 'r*', 'LineWidth', 2);

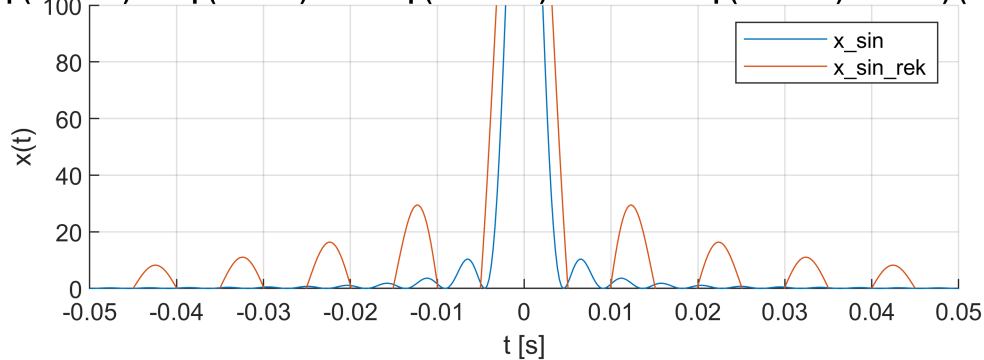
```
xlabel('\omega [rad/s]'); ylabel('|X(\omega)|')
legend('Okno filtra rek.', 'Widmo');
```

```
subplot(2,1,2); hold on; grid on;
ezplot(x_sin, BND_t); % syg. próbkowany
ezplot(x_sin_rek, BND_t) % syg. odtworzony
ylim([0 100])
xlabel('t [s]'); ylabel('x(t)')
legend('x\_sin', 'x\_sin\_rek');
```

$\text{triangularPulse}(-440\pi, 0, 440\pi, w) + \dots + \text{triangularPulse}(-440\pi, 0, 440\pi, w + 1200\pi)$



$-(\exp(-x\pi 40i) + \exp(x\pi 40i) - x\pi \exp(-x\pi 200i) 480i + x\pi \exp(x\pi 200i) 480i - 2)/(880x^2\pi$



% Zadanie 4

%d)

s = 16/5;

ws = s*wg;

x_sin = ifourier(triangularPulse(-ws, ws, w));

X_FT_sin_org = triangularPulse(-ws, ws, w);

X_FT_sin = X_FT_sin_org + ... % oryginal widma

symsum((subs(X_FT_sin_org, w, w - K*wp) + ...% 3 aliasy lewe
subs(X_FT_sin_org, w, w + K*wp)), K, 1, 3); % 3 aliasy prawe

FILT_FT = rectangularPulse(-wg, wg, w); % filtr rekonstruujący

x_sin_rek = ifourier(X_FT_sin*FILT_FT); % odwr. tarnsf. Fouriera

BND_t = [-10/fp; 10/fp];

%t_SMP = [BND_t(1):1/(10*fp):BND_t(2)];

```

BND_w = [-4*wp;4*wp];
w_SMP = [BND_w(1):wp/10:BND_w(2)];

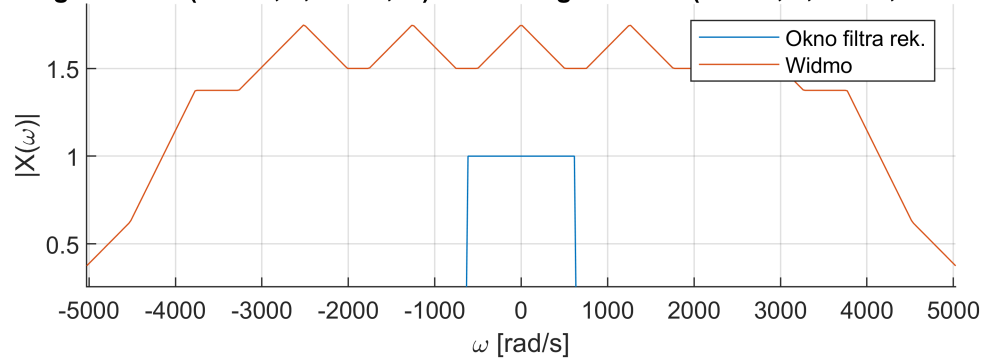
figure; subplot(2,1,1); hold on; grid on;
ezplot(FILT_FT,BND_w); %okno filtru rek.
ezplot(X_FT_sin,BND_w)

v_num = abs(double(subs(X_FT_sin, w, w_SMP)));
n = find(abs(v_num) == Inf);
stem(w_SMP(n),sign(v_num(n)), 'r*', 'LineWidth', 2);
xlabel('\omega [rad/s]'); ylabel('|X(\omega)|')
legend('Okno filtra rek.','Widmo');

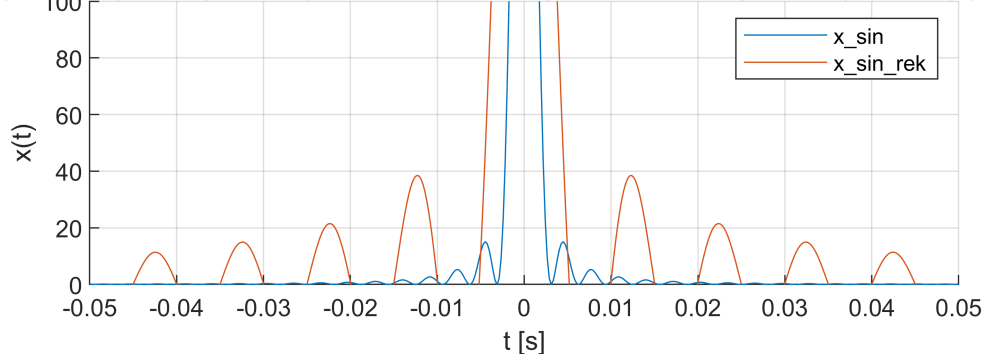
subplot(2,1,2); hold on; grid on;
ezplot(x_sin, BND_t); % syg. próbkowany
ezplot(x_sin_rek, BND_t) % syg. odtworzony
ylim([0 100])
xlabel('t [s]'); ylabel('x(t)')
legend('x\_sin','x\_sin\_rek');

```

triangularPulse(-640 π , 0, 640 π , w) +...+ triangularPulse(-640 π , 0, 640 π , w + 1200 π)



$(\exp(-x \pi 160i) + \exp(x \pi 160i) - x \pi \exp(-x \pi 200i) 960i + x \pi \exp(x \pi 200i) 960i - 2)/(1280 x^2)$



% Zadanie 4

%e)

s = 4/5;

ws = s*wg;

x_sin = ifourier(triangularPulse(-ws, ws, w));

X_FT_sin_org = triangularPulse(-ws, ws, w);


```

X_FT_sin = X_FT_sin_org + ... % oryginal widma
    symsum((subs(X_FT_sin_org, w, w - K*wp ) + ...% 3 aliasy lewe
    subs(X_FT_sin_org, w, w + K*wp)), K , 1, 3); % 3 aliasy prawe

FILT_FT = rectangularPulse(-wg, wg, w); % filtr rekonstruujący
x_sin_rek = ifourier(X_FT_sin * FILT_FT); % odwr. transf. Fouriera

BND_t = [-10/fp; 10/fp];
%t_SMP = [BND_t(1):1/(10*fp):BND_t(2) ];
BND_w = [-4*wp; 4*wp];
w_SMP = [BND_w(1):wp/10:BND_w(2)];

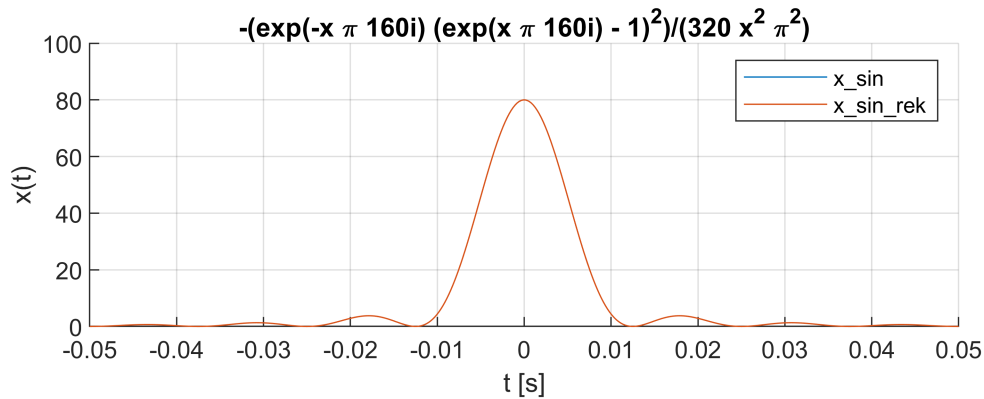
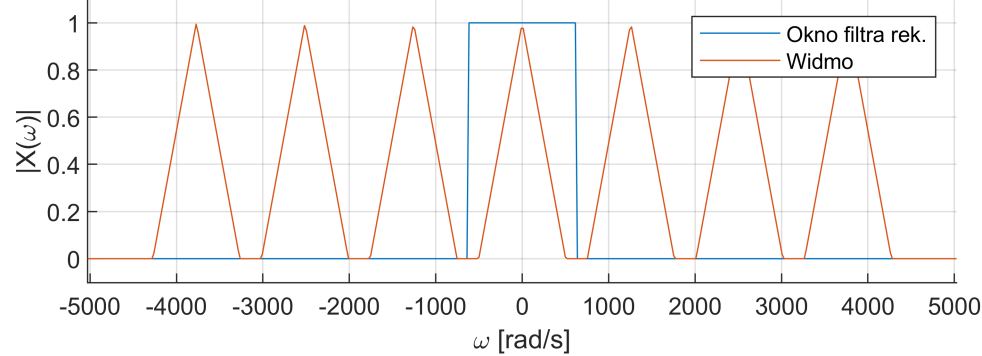
figure; subplot(2,1,1); hold on; grid on;
ezplot(FILT_FT, BND_w); %okno filtru rek.
ezplot(X_FT_sin, BND_w)

v_num = abs(double(subs(X_FT_sin, w, w_SMP)));
n = find(abs(v_num) == Inf);
stem(w_SMP(n), sign(v_num(n)), 'r*', 'LineWidth', 2);
xlabel('\omega [rad/s]'); ylabel('|X(\omega)|')
legend('Okno filtra rek.', 'Widmo');

subplot(2,1,2); hold on; grid on;
ezplot(x_sin, BND_t); % syg. próbkowany
ezplot(x_sin_rek, BND_t) % syg. odtworzony
ylim([0 100])
xlabel('t [s]'); ylabel('x(t)')
legend('x_sin', 'x_sin_rek');

```

triangularPulse(-160 π , 0, 160 π , w) + ... + triangularPulse(-160 π , 0, 160 π , w + 1200 π)



% Zadanie 4

%f)

s = 9/5;

ws = s*wg;

x_sin = ifourier(triangularPulse(-ws, ws, w));

X_FT_sin_org = triangularPulse(-ws, ws, w);

X_FT_sin = X_FT_sin_org + ... % oryginal widma

symsum((subs(X_FT_sin_org, w, w - K*wp) + ...% 3 aliasy lewe

subs(X_FT_sin_org, w, w + K*wp)), K, 1, 3); % 3 aliasy prawe

FILT_FT = rectangularPulse(-wg, wg, w); % filtr rekonstruujujcy

x_sin_rek = ifourier(X_FT_sin * FILT_FT); % odwr. tarnsf. Fouriera

BND_t = [-10/fp; 10/fp];

%t_SMP = [BND_t(1):1/(10*fp):BND_t(2)];

BND_w = [-4*wp; 4*wp];

w_SMP = [BND_w(1):wp/10:BND_w(2)];

figure; subplot(2,1,1); hold on; grid on;

ezplot(FILT_FT, BND_w); %okno filtru rek.

ezplot(X_FT_sin, BND_w)

v_num = abs(double(subs(X_FT_sin, w, w_SMP)));

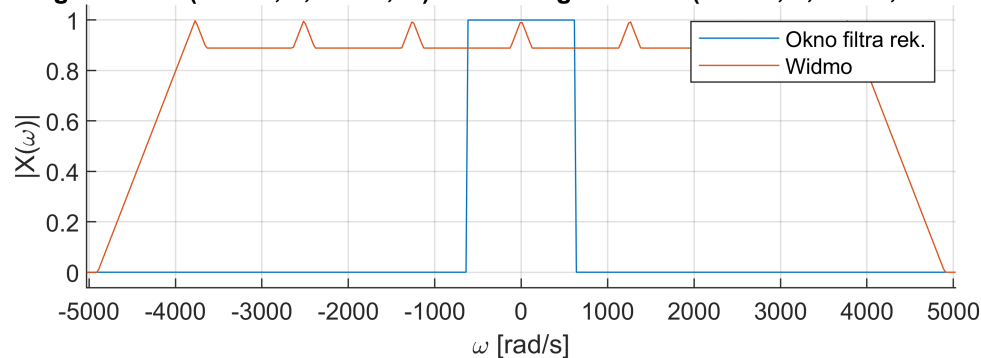
n = find(abs(v_num) == Inf);

stem(w_SMP(n), sign(v_num(n)), 'r*', 'LineWidth', 2);

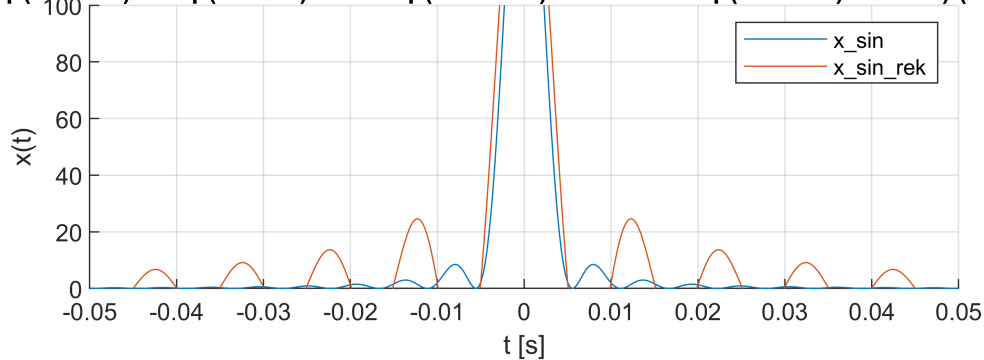
```
xlabel('\omega [rad/s]'); ylabel('|X(\omega)|')
legend('Okno filtra rek.', 'Widmo');
```

```
subplot(2,1,2); hold on; grid on;
ezplot(x_sin, BND_t); % syg. próbkowany
ezplot(x_sin_rek, BND_t) % syg. odtworzony
ylim([0 100])
xlabel('t [s]'); ylabel('x(t)')
legend('x\_sin', 'x\_sin\_rek');
```

$\text{triangularPulse}(-360\pi, 0, 360\pi, w) + \dots + \text{triangularPulse}(-360\pi, 0, 360\pi, w + 1200\pi)$



$-(\exp(-x\pi 40i) + \exp(x\pi 40i) - x\pi \exp(-x\pi 200i) 320i + x\pi \exp(x\pi 200i) 320i - 2)/(720 x^2 \pi$



% Zadanie 4

%g)

s = 14/5;

ws = s*wg;

x_sin = ifourier(triangularPulse(-ws, ws, w));

X_FT_sin_org = triangularPulse(-ws, ws, w);

X_FT_sin = X_FT_sin_org + ... % oryginalne widmo

symsum((subs(X_FT_sin_org, w, w - K*wp) + ...% 3 aliasy lewe
subs(X_FT_sin_org, w, w + K*wp)), K, 1, 3); % 3 aliasy prawe

FILT_FT = rectangularPulse(-wg, wg, w); % filtr rekonstruujący

x_sin_rek = ifourier(X_FT_sin * FILT_FT); % odwr. transf. Fouriera

BND_t = [-10/fp; 10/fp];

%t_SMP = [BND_t(1):1/(10*fp):BND_t(2)];

```

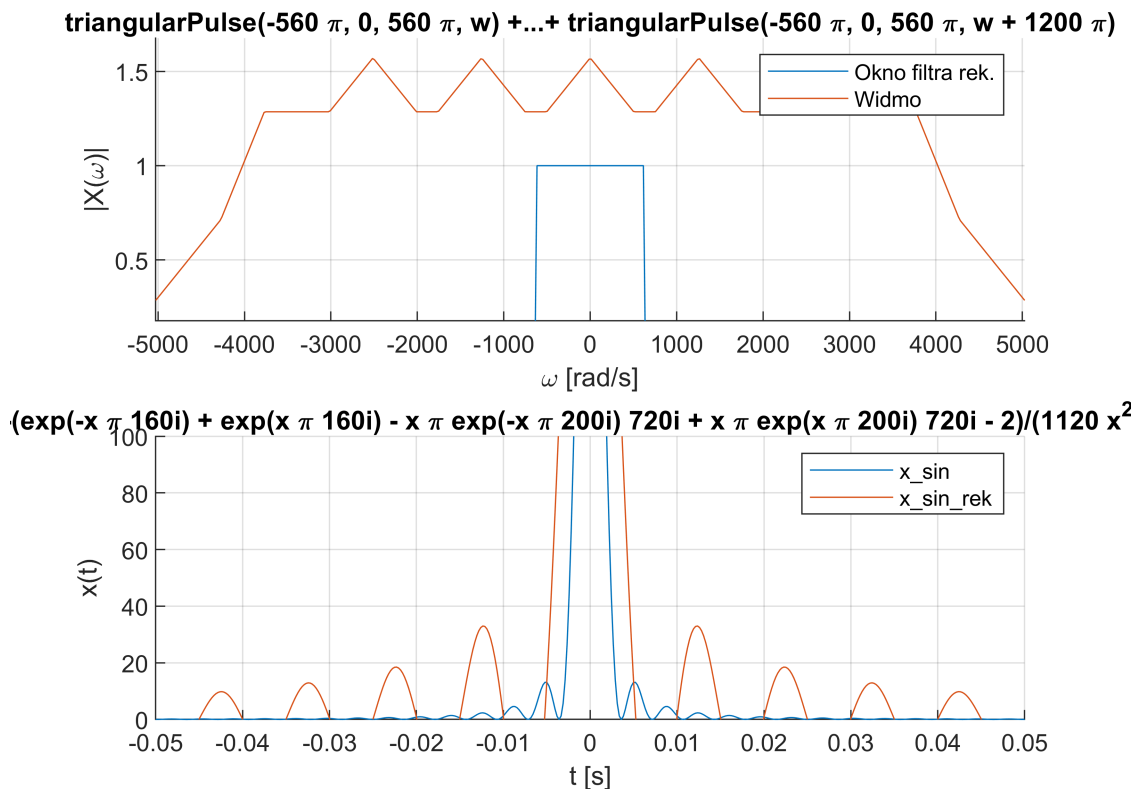
BND_w = [-4*wp;4*wp];
w_SMP = [BND_w(1):wp/10:BND_w(2)];

figure; subplot(2,1,1); hold on; grid on;
ezplot(FILT_FT,BND_w); %okno filtru rek.
ezplot(X_FT_sin,BND_w)

v_num = abs(double(subs(X_FT_sin, w, w_SMP)));
n = find(abs(v_num) == Inf);
stem(w_SMP(n),sign(v_num(n)), 'r*', 'LineWidth', 2);
xlabel('\omega [rad/s]'); ylabel('|X(\omega)|')
legend('Okno filtra rek.','Widmo');

subplot(2,1,2); hold on; grid on;
ezplot(x_sin, BND_t); % syg. próbkowany
ezplot(x_sin_rek, BND_t) % syg. odtworzony
ylim([0 100])
xlabel('t [s]'); ylabel('x(t)')
legend('x\_sin','x\_sin\_rek');

```



```

% Zadanie 5
clear all;
syms t x w K;
fp = 200;
fg = fp/2;
wp = 2*pi*fp;

```

```

wg = 2*pi*fg;
s = 1/5;
ws = s*wg;
fs = s * fg;
T = 1/fs;

% oryginalny przebieg prostokątny
x = rectangularPulse(0, t/2, t);
% Kod generujący wyrazy szeregu Fouriera
NT = 50;
sumX = 0;
ind=-NT:NT;
BND = [-T/2, T/2];
for n = ind
    Xn = 1/T*int(x*exp(-1i*ws*n*t),t,BND);
    % Wzór (8) z konspektu.
    % Tworzy X(jw) ze współczynników Xn
    sumX = sumX + Xn * dirac(w - n*ws);
end
X_FT_org = 2*pi * sumX;

FILT_FT = rectangularPulse(-wg, wg, w); % filtr rekonstruujący
x_ft_rek = ifourier(X_FT_org*FILT_FT); % odwr. tarnsf. Fouriera

BND_t = [-10/fp; 10/fp];
t_SMP = [BND_t(1):1/(10*fp):BND_t(2) ];
BND_w = [-3*wp; 3*wp];
w_SMP = [BND_w(1):wp/10:BND_w(2)];

figure; subplot(2,1,1); hold on; grid on;
ezplot(FILT_FT, BND_w); %okno filtru rek.
ezplot(X_FT_org, BND_w)

v_num = subs(imag(X_FT_org), w, w_SMP);
n = find(abs(v_num) == Inf);
stem(w_SMP(n), abs(sign(v_num(n))), 'r*', 'LineWidth', 2);
xlabel('\omega [rad/s]'); ylabel('|X(\omega)|')
legend('Okno filtra rek.', 'Widmo');

v_num = subs(real(X_FT_org), w, w_SMP);
n = find(abs(v_num) == Inf);
stem(w_SMP(n), abs(sign(v_num(n))), 'r*', 'LineWidth', 2);

subplot(2,1,2); hold on; grid on;
ezplot(fourier(X_FT_org), BND_t); % syg. próbkowany
ezplot(x_ft_rek, BND_t) % syg. odtworzony
ylim([0 100])
xlabel('t [s]'); ylabel('x(t)')
legend('x\_sin', 'x\_sin\_rek');

```