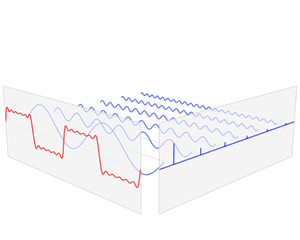
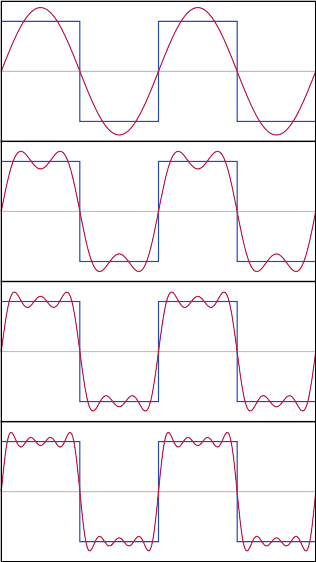
# Obwody elektryczne, elektroniczne



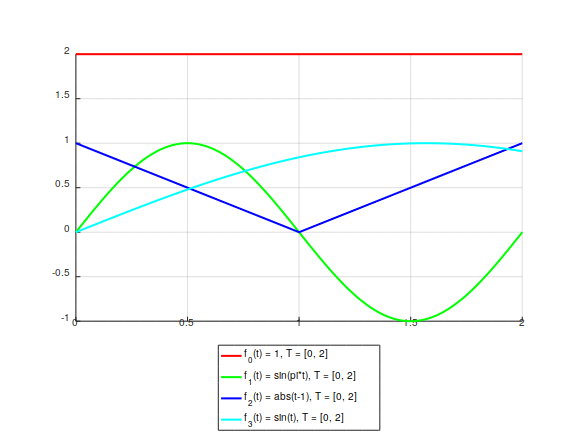
Rys. Związek Serii Furiera z funkcją w dziedzinie częstotliwości [By Lucas V. Barbosa - File:Fourier transform time and frequency domains (small).gif, CC0, <https://commons.wikimedia.org/w/index.php?curid=28399050>]

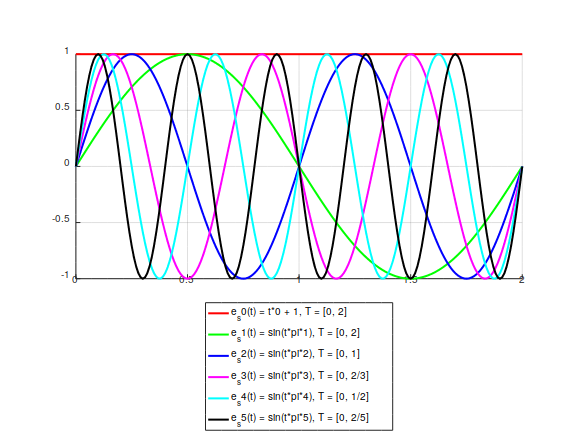
|  |  |
| --- | --- |
|  |  |
|  |  |
|  |  |
|  |  |
| Sin | Cos |

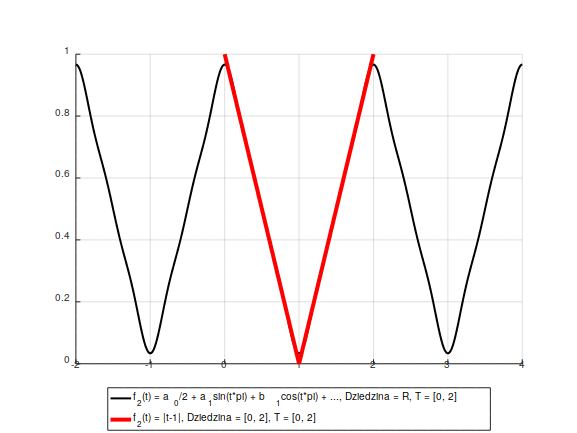
|  |  |  |
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|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
| Sin sin | Sin cos | Cos cos |

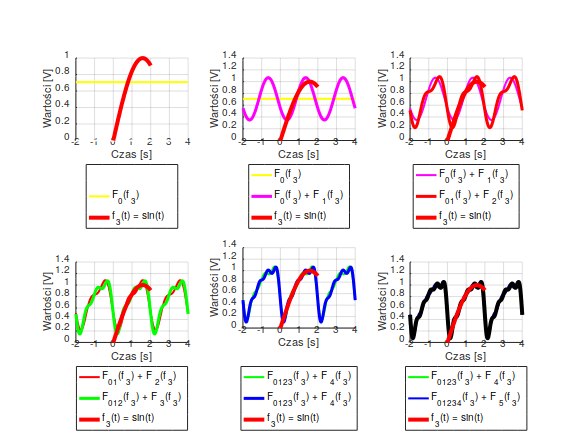


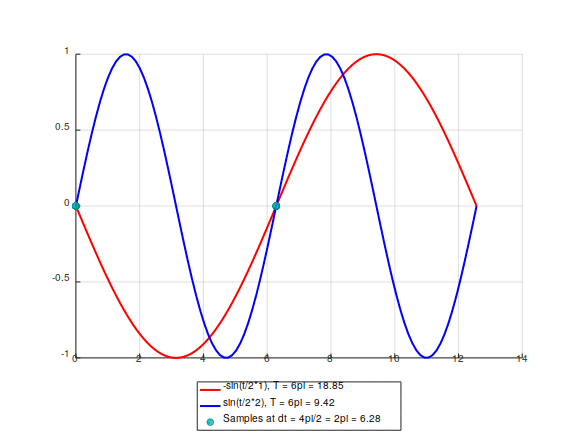
Rys. Sumy częściowe szeregu Fourier’a dla fali kwadratowej.

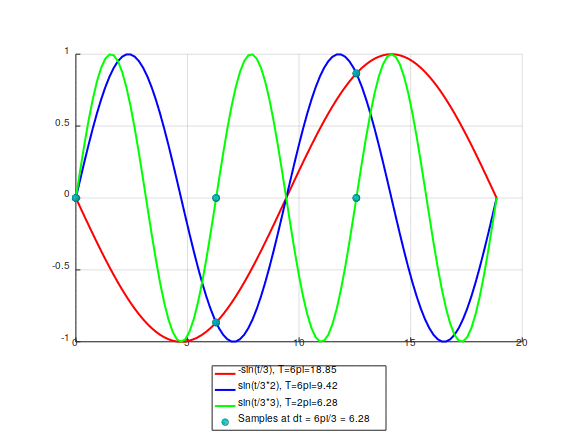


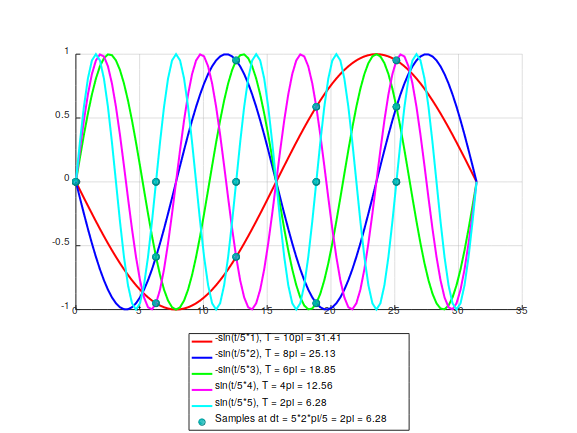


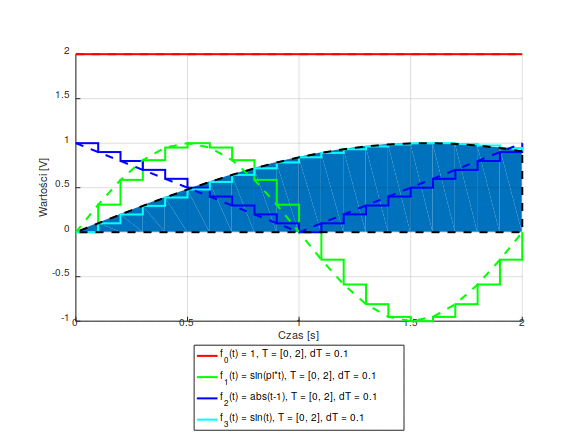


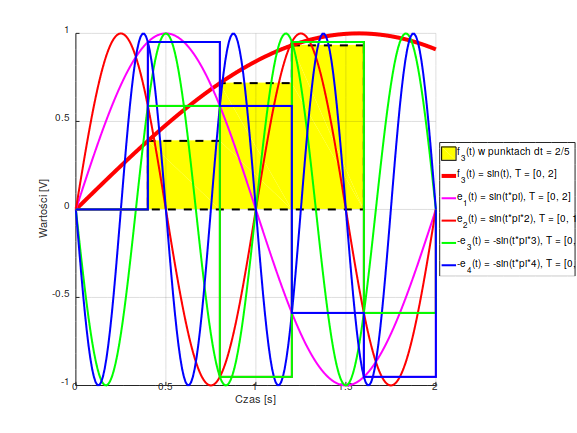












## Przykład Matlab/Octave

% problem

% jak wygląda funkcja f(t) przedstawiona w postaci szeregu Fourier'a?

% do 5-tego elementu

f0 = @(t) 2+0\*t; % w przedziale [0, 2]

f1 = @(t) sin(pi\*t); % w przedziale [0, 2]

f2 = @(t) abs(t-1); % w przedziale [0, 2]

f3 = @(t) sin(t); % w przedziale [0, 2]

ts = 0:0.01:2;

%figure;

%hold 'on';

%grid 'on';

%p0 = plot(ts, f0(ts), 'linewidth', 2, 'color', 'red');

%p1 = plot(ts, f1(ts), 'linewidth', 2, 'color', 'green');

%p2 = plot(ts, f2(ts), 'linewidth', 2, 'color', 'blue');

%p3 = plot(ts, f3(ts), 'linewidth', 2, 'color', 'cyan');

%legend([p0,p1,p2,p3],

%"f\_0(t) = 1, T = [0, 2]",

%"f\_1(t) = sin(pi\*t), T = [0, 2]",

%"f\_2(t) = abs(t-1), T = [0, 2]",

%"f\_3(t) = sin(t), T = [0, 2]",

%"location", "southoutside");

%%print -dsvg ExampleFunctionsOn0to2.svg; %%% zapisanie okna do pliku

% e1(t) potrzeba aby miało okres T1 = [0,2] natomiast wiadomo że ma [0, 2\*pi]

% jak należy wyskalować argument t żeby tak było? (a później wprowadzić to

% skalowanie do wnętrza e1)

% no więc efekt ma być taki: 0 -> 0, 2 -> 2\*pi

% czyli jak t pomnożymy przez pi to tak będzie.

% w związku z tym funkcje bazowe będą postaci:

es0 = @(t) t\*0 + 1; % sin(t\*pi\*0) == 1, T0 jest dowolny

ec0 = @(t) t\*0; % cos(t\*pi\*0) == 0, T0 jest dowolny

es1 = @(t) sin(t\*pi\*1); % T1 == [0, 2\*pi/pi] == [0, 2]

ec1 = @(t) cos(t\*pi\*1); % T1 == [0, 2\*pi/pi] == [0, 2]

es2 = @(t) sin(t\*pi\*2); % T2 == [0, 2\*pi/2/pi] == [0, 1] == 1/2 \* T1

ec2 = @(t) cos(t\*pi\*2); % T2 == [0, 2\*pi/2/pi] == [0, 1] == 1/2 \* T1

es3 = @(t) sin(t\*pi\*3); % T3 == [0, 2\*pi/3/pi] == [0, 2/3] == 1/3 \* T1

ec3 = @(t) cos(t\*pi\*3); % T3 == [0, 2\*pi/3/pi] == [0, 2/3] == 1/3 \* T1

es4 = @(t) sin(t\*pi\*4); % T4 == [0, 2\*pi/4/pi] == [0, 1/2] == 1/4 \* T1

ec4 = @(t) cos(t\*pi\*4); % T4 == [0, 2\*pi/4/pi] == [0, 1/2] == 1/4 \* T1

es5 = @(t) sin(t\*pi\*5); % T5 == [0, 2\*pi/5/pi] == [0, 2/5] == 1/5 \* T1

ec5 = @(t) cos(t\*pi\*5); % T5 == [0, 2\*pi/5/pi] == [0, 2/5] == 1/5 \* T1

ts = 0:0.01:2;

%figure;

%hold 'on';

%grid 'on';

%p0 = plot(ts, es0(ts), 'linewidth', 2, 'color', 'red');

%p1 = plot(ts, es1(ts), 'linewidth', 2, 'color', 'green');

%p2 = plot(ts, es2(ts), 'linewidth', 2, 'color', 'blue');

%p3 = plot(ts, es3(ts), 'linewidth', 2, 'color', 'magenta');

%p4 = plot(ts, es4(ts), 'linewidth', 2, 'color', 'cyan');

%p5 = plot(ts, es5(ts), 'linewidth', 2, 'color', 'black');

%legend([p0,p1,p2,p3,p4,p5],

%"e\_s0(t) = t\*0 + 1, T = [0, 2]",

%"e\_s1(t) = sin(t\*pi\*1), T = [0, 2]",

%"e\_s2(t) = sin(t\*pi\*2), T = [0, 1]",

%"e\_s3(t) = sin(t\*pi\*3), T = [0, 2/3]",

%"e\_s4(t) = sin(t\*pi\*4), T = [0, 1/2]",

%"e\_s5(t) = sin(t\*pi\*5), T = [0, 2/5]",

%"location", "southoutside");

%%print -dsvg FurierBasesOn0to2.svg; %%% zapisanie okna do pliku

% teraz obliczymy współczynniki szeregu Fourier'a dla f2:

f2a0 = quad(@(t) f2(t).\*es0(t), 0, 2)/2;

f2b0 = quad(@(t) f2(t).\*ec0(t), 0, 2)/2;

f2a1 = quad(@(t) f2(t).\*es1(t), 0, 2);

f2b1 = quad(@(t) f2(t).\*ec1(t), 0, 2);

f2a2 = quad(@(t) f2(t).\*es2(t), 0, 2);

f2b2 = quad(@(t) f2(t).\*ec2(t), 0, 2);

f2a3 = quad(@(t) f2(t).\*es3(t), 0, 2);

f2b3 = quad(@(t) f2(t).\*ec3(t), 0, 2);

f2a4 = quad(@(t) f2(t).\*es4(t), 0, 2);

f2b4 = quad(@(t) f2(t).\*ec4(t), 0, 2);

f2a5 = quad(@(t) f2(t).\*es5(t), 0, 2);

f2b5 = quad(@(t) f2(t).\*ec5(t), 0, 2);

% teraz przedstawmy funkcję w postaci szeregu Furier'a:

f2Furier0 = @(t) f2a0\*es0(t) + f2b0\*ec0(t);

f2Furier1 = @(t) f2a1\*es1(t) + f2b1\*ec1(t);

f2Furier2 = @(t) f2a2\*es2(t) + f2b2\*ec2(t);

f2Furier3 = @(t) f2a3\*es3(t) + f2b3\*ec3(t);

f2Furier4 = @(t) f2a4\*es4(t) + f2b4\*ec4(t);

f2Furier5 = @(t) f2a5\*es5(t) + f2b5\*ec5(t);

f2Furier01 = @(t) f2Furier0(t) + f2Furier1(t);

f2Furier012 = @(t) f2Furier01(t) + f2Furier2(t);

f2Furier0123 = @(t) f2Furier012(t) + f2Furier3(t);

f2Furier01234 = @(t) f2Furier0123(t) + f2Furier4(t);

f2Furier = @(t) f2Furier0(t) + f2Furier1(t) + f2Furier2(t) + f2Furier3(t) + f2Furier4(t) + f2Furier5(t);

tsts = -2:0.01:4;

%figure;

%hold 'on';

%grid 'on';

%p0 = plot(tsts, f2Furier0(tsts), 'linewidth', 2, 'color', 'yellow');

%p1 = plot(tsts, f2Furier01(tsts), 'linewidth', 2, 'color', 'magenta');

%p2 = plot(tsts, f2Furier012(tsts), 'linewidth', 2, 'color', 'red');

%p3 = plot(tsts, f2Furier0123(tsts), 'linewidth', 2, 'color', 'green');

%p4 = plot(tsts, f2Furier01234(tsts), 'linewidth', 2, 'color', 'blue');

%p5 = plot(tsts, f2Furier(tsts), 'linewidth', 2, 'color', 'black');

%p = plot(ts, f2(ts), 'linewidth', 4, 'color', 'red');

%legend([p,p0,p1,p2,p3,p4,p5],

%%legend([p,p1,p3,p5],

%"f\_2(t) = |t-1|, Dziedzina = [0, 2], T = [0, 2]",

%"f\_2(t) = a\_0/2, Dziedzina = R, T = [0, 2]",

%"f\_2(t) = a\_0/2 + a\_1 sin(t\*pi) + b\_1 cos(t\*pi), Dziedzina = R, T = [0, 2]",

%"f\_2(t) = ... + a\_2 sin(t\*pi\*2) + b\_2 cos(t\*pi\*2), Dziedzina = R, T = [0, 2]",

%"f\_2(t) = ... + a\_3 sin(t\*pi\*3) + b\_3 cos(t\*pi\*3), Dziedzina = R, T = [0, 2]",

%"f\_2(t) = ... + a\_4 sin(t\*pi\*4) + b\_4 cos(t\*pi\*4), Dziedzina = R, T = [0, 2]",

%"f\_2(t) = a\_0/2 + a\_1 sin(t\*pi) + b\_1 cos(t\*pi) + ... + a\_5 sin(t\*pi\*5) + b\_5 cos(t\*pi\*5), Dziedzina = R, T = [0, 2]",

%"location", "southoutside");

%xlabel('Czas [s]');

%ylabel('Wartości [V]');

%%print -dsvg FurierSeries.svg; %%% zapisanie okna do pliku