Hands-on : Fourier analysis and synthesis

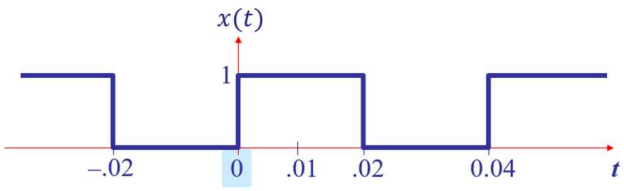
Fseriesdemo

1. Run fseriesdemo and play with the tool for some time to understand the Fourier synthesis.

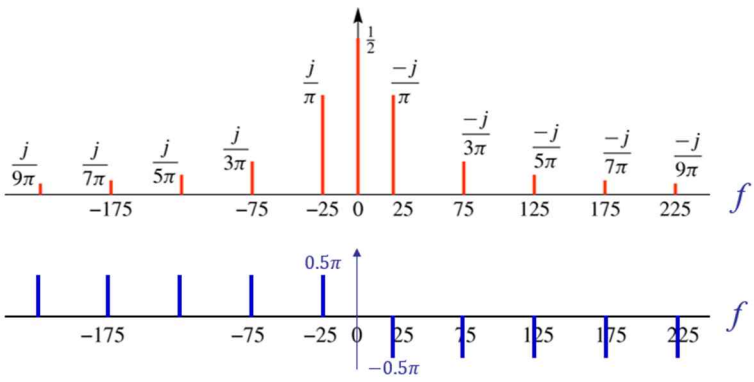
Fourier analysis1 : square wave

2. Download fscreate.m from the class site on the KULMS.
3. Learn the usage of the function fscreate.
4. Using fscreate, create a square wave for example1 in the class materials and get Fourier series coefficients.

$$x(t) = \begin{cases} 1 & 0 \le t < \frac{1}{2}T_0 \\ 0 & \frac{1}{2}T_0 \le t < T_0 \end{cases}$$



1) Make a vecter **t** for time grids from $0\ sec$ to $T_0\ sec$ with $0.005\ sec$ interval.
2) Make a vector **f** for the square wave signal values with respect to the grids in the vector **t**.
3) Run fscreate with **t** and **f**. (Use 6 harmonics and piecewise constant between the data points.)
4) Display ALL THE RESULTS (returned values) after running fscreate(). (Use the appropriate parameters of FSfun() listed on the next pages.)
5) Display the values(complex amplitudes) Fourier series coefficients.
6) Plot the square wave signal created in 4.2) and resultant plot using 6 harmonics in 4.3). Use stem() for the signal created in 4.2)
7) Draw magnitude and phase plots of the coefficients. Use stem().
8) Compare the results with those plots in the class materials. Describe your reasoning for the observed differences between the two plots.



%---
% usage of fscreate()
%---
FSfun = fscreate(**t**, **f**, **N**, **TYPE**) computes the Fourier Series of a signal tabulated in the real-valued data vectors t and f.

- **t** is a monotonically increasing time vector with the signal period being
  T = t(end)-t(1).
- **f** is a periodic signal vector corresponding to the time t. f(1)=f(end) is required.
- **N** is the number of harmonics. If N is empty or not given, N = 64.
- **TYPE** is a string describing the signal type described by the data t and f.
  If TYPE is not given or if TYPE = 'foh' (First Order Hold, textbook page 143),
  the Fourier Series coefficients are computed by assuming that the input data is
  piecewise linear between the data points.
  If TYPE = 'zoh' (Zero Order Hold, textbook page 143),
  the Fourier Series coefficients are computed by assuming
  that the input data is piecewise constant between the data points.

%---
% how to access the output of fscreate()
%---
The created Fourier Series function handle FSfun provides the following:

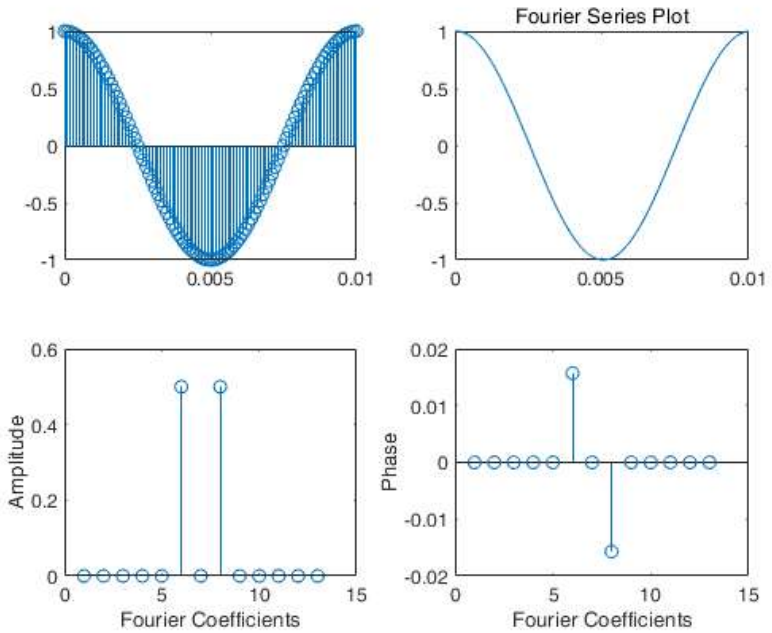
SYNTAX	DESCRIPTION
FSfun(t)	evaluate function at the points in numerical array t.
FSfun('tag')	return the Tag string stored in FSfun.
FSfun('coef')	return Fourier Series coefficient row vector, Kn.
FSfun('period')	return function period, T.
FSfun('size')	return number of harmonics, N.
FSfun('avg')	return DC or average value.
FSfun('msv')	return mean square value (Parseval's Theorem).
FSfun('max')	return maximum function value.
FSfun('min')	return minimum function value.
FSfun('thd')	return total harmonic distortion relative to fundamental.
FSfun('one')	return one-sided line spectra amplitude vector, i.e. [|K(0)|, 2*|K(1)|, ..., 2*|K(N)|]
FSfun('phase')	return one-sided line spectra phase vector in Degrees, i.e., [angle(K(0)) angle(K(1)) ... angle(K(N))]
FSfun('sine')	return a vector of the one-sided Fourier Series sine coefficients, sine portion of trigonometric FS form
FSfun('cosine')	return a vector of the one-sided Fourier Series cosine coefficients, cosine portion of trigonometric FS form
FSfun('all')	return a structure having field names equal to the above string arguments with contents equal to associated data as described above, e.g., out.coef is the coefficients.
FSfun('plot')	create a TIME plot of one period of the Fourier Series
FSfun('spectra')	create a STEM plot of the one-sided spectra

FSfun({'area', [Tmin Tmax]}) returns the area under the Fourier Series over the time range
Tmin <= t <= Tmax.
FSfun({'plot', [Tmin Tmax]}) creates the TIME plot over the time range Tmin <= t <= Tmax.
FSfun({'spectra', [Nmin Nmax]}) creates the STEM plot over the positive harmonic index range
Nmin to Nmax.
%---

Fourier analysis 2

Repeat the above process for the following signals

5. $x(t) = \cos(200\pi t)$



6. $x(t) = \sum_{k=1}^{6} \frac{\sin\left(\frac{\pi k}{2}\right)\cos\left(\frac{\pi k t}{2}\right)}{\pi k}$