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| **Course Name:** | **Networks, Signals and Systems** | **Semester:** | **III** |
| **Date of Performance:** |  | **Batch No:** | **A - 3** |
| **Faculty Name:** |  | **Roll No:** | **16014022050** |
| **Faculty Sign & Date:** |  | **Grade/Marks:** | **\_\_\_ / 25** |

**Experiment No: 9**

**Title: Fourier Analysis of given periodic and non-periodic signals**

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| **Aim and Objective of the Experiment:** |
| Fourier Analysis of given periodic and non-periodic signals. |

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| **COs to be achieved:** |
| **CO5:** Apply Fourier series and transform for spectral analysis. |

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| **Theory:** |
| 1. **Fourier Series –**   Fourier discovered that any periodic signal could be represented as a sum of sinusoids. A waveform with periodicity T seconds and frequency can be represented as the sum of sinusoids with frequencies that are integer multiples of . (, 2, 3, etc.).  Mathematically we would write:   1. **Fourier Transform –**   The Fourier transform of a function of time is a complex-valued function of frequency, whose magnitude represents the amount of that frequency present in the original function, and whose argument is the phase offset of the basic sinusoid in that frequency. The Fourier transform is not limited to functions of time, but the domain of the original function is commonly referred to as the time domain.  If the spectrum of continuous time periodic signal is x(t), then,  The exponential form of Fourier series of x(t) is given by, |

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| **Stepwise-Procedure:** |
| 1. **Fourier Series –** 2. **Determine the trigonometric form of Fourier series on the following:**    1. **Signals having even symmetry**   close all;  clear all;  clc;  % Define the parameters  fs = 1000; % Sampling frequency  N = 1024; % Number of samples  t = linspace(0, 2\*pi, N); % Time vector for one period of the cosine function  % Define an even function (used cosine)  f = 1; % Frequency of the cosine function  A = 0.8; % Amplitude of the cosine function  x = A \* cos(2 \* pi \* f \* t);  % Plot the original signal  subplot(3,1,1);  plot(t, x);  grid;  xlabel('Time');  ylabel('Amplitude');  title('Even Input Signal (ketaki)');  % Calculate the Fourier coefficients  N = length(x);  n = 0:N-1;  k = 0:N-1;  X = zeros(size(k));  for i = 1:length(k)  X(i) = sum(x .\* exp(-1i\*2\*pi\*k(i)\*n/N));  end  % Extracting the Fourier coefficients  ao = X(1)/N;  an = 2\*real(X(2:end))/N;  bn = -2\*imag(X(2:end))/N;  % Printing the coefficients  fprintf('Fourier Coefficients: \na0 = %.4f\n', ao);  for i = 1:length(an)  fprintf('a%d = %.4f, b%d = %.4f\n', i, an(i), i, bn(i));  end  % Calculate the magnitude spectrum  Xmag = abs(X);  subplot(3,1,2);  plot(k, Xmag);  grid;  xlabel('Frequency');  ylabel('Magnitude');  title('Magnitude Spectrum of Even Signal (ketaki)');  % Calculate the phase spectrum  Xphase = angle(X) \* (180/pi);  subplot(3,1,3);  plot(k, Xphase);  grid;  xlabel('Frequency');  ylabel('Phase (degrees)');  title('Phase Spectrum of Even Signal (ketaki)');   * 1. **Signals having odd symmetry**   close all;  clear all;  clc;  % Define the parameters  fs = 1000; % Sampling frequency  N = 1024; % Number of samples  t = linspace(0, 2\*pi, N); % Time vector for one period of the sine function  % Define an even function (used sine)  f = 1; % Frequency of the sine function  A = 0.8; % Amplitude of the sine function  x = A \* sin(2 \* pi \* f \* t);  % Plot the original signal  subplot(3,1,1);  plot(t, x);  grid;  xlabel('Time');  ylabel('Amplitude');  title('Odd Input Signal (ketaki)');  % Calculate the Fourier coefficients  N = length(x);  n = 0:N-1;  k = 0:N-1;  X = zeros(size(k));  for i = 1:length(k)  X(i) = sum(x .\* exp(-1i\*2\*pi\*k(i)\*n/N));  end  % Extracting the Fourier coefficients  ao = X(1)/N;  an = 2\*real(X(2:end))/N;  bn = -2\*imag(X(2:end))/N;  % Printing the coefficients  fprintf('Fourier Coefficients: \na0 = %.4f\n', ao);  for i = 1:length(an)  fprintf('a%d = %.4f, b%d = %.4f\n', i, an(i), i, bn(i));  end  % Calculate the magnitude spectrum  Xmag = abs(X);  subplot(3,1,2);  plot(k, Xmag);  grid;  xlabel('Frequency');  ylabel('Magnitude');  title('Magnitude Spectrum of Odd Signal (ketaki)');  % Calculate the phase spectrum  Xphase = angle(X) \* (180/pi);  subplot(3,1,3);  plot(k, Xphase);  grid;  xlabel('Frequency');  ylabel('Phase (degrees)');  title('Phase Spectrum of Odd Signal (ketaki)');   1. **Obtain the Fourier coefficients for step 1.** 2. **Plot the magnitude and phase spectrum.** 3. **Upload the results in the experiment document.** 4. **Fourier Transform –** 5. **Determine the Fourier Transform of the given continuous time domain.**   close all;  clear all;  clc;  % Define the parameters  fs = 1000; % Sampling frequency  N = 1024; % Number of samples  t = (0:N-1) \* (1/fs); % Time vector  % Define a continuous-time signal (cosine in this case)  f = 10; % Frequency of the cosine function  A = 0.8; % Amplitude of the cosine function  x = A \* cos(2 \* pi \* f \* t);  % Plot the original signal  subplot(3,1,1);  plot(t, x);  grid;  xlabel('Time');  ylabel('Amplitude');  title('Continuous Time Signal (ketaki)');  % Compute the Fourier transform  X = fft(x);  % Compute the magnitude spectrum  Xmag = abs(X);  frequencies = linspace(0, fs, N);  subplot(3,1,2);  plot(frequencies, Xmag);  grid;  xlabel('Frequency (Hz)');  ylabel('Magnitude');  title('Magnitude Spectrum of Continuous Time Signal (ketaki)');  % Compute the phase spectrum  Xphase = angle(X) \* (180/pi);  subplot(3,1,3);  plot(frequencies, Xphase);  grid;  xlabel('Frequency (Hz)');  ylabel('Phase (degrees)');  title('Phase Spectrum of Continuous Time Signal (ketaki)');   1. **Plot the magnitude and phase spectrum.** 2. **Upload the results in the experiment document.** |

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| **Observations:** |
| 1. **Q1. a. Fourier series (Signals having Even Symmetry) –** |
| **Magnitude Spectrum –** |
| **Phase Spectrum –** |
| **A. Q2. Fourier Coefficients –** |
| 1. **Q1. b. Fourier series (Signals having Odd Symmetry) –** |
| **Magnitude Spectrum –** |
| **Phase Spectrum –** |
| 1. **Q2. Fourier Coefficients –** |
| 1. **Fourier Transform –** |
| **Magnitude Spectrum –** |
| **Phase Spectrum –** |

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| **Post Lab Subjective/Objective type Questions:** |
| 1. **Solve theoretically the numerical performed in the lab and upload the handwritten solution in the document.** |

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| **Conclusion:** |
| In conclusion, the experiment successfully demonstrated the application of Fourier analysis on both even and off signals, providing valuable insights into the frequency components of these signals. This experiment has enhanced our understanding of Fourier analysis, its applications, and its importance in signal processing. |

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| **Signature of faculty in-charge with Date:** |