Signal & System Analyzer

Vivesvaraya National Institute of Technology

ELECTRICAL AND ELECTRONICS ENGINEERING

PROGRAMMING TECHINQUES AND SIMULATION LABORATORY

STUDENT DETAILS

	Aditya Ojha
	BT23EEE032

MATLAB APPLICATION

NOTE: Please install Symbolic Math Toolbox before running the app to avoid any errors.

AIM

To create a MATLAB app that computes and visualises the Laplace Transform, Fourier Transform, and Z-Transform of user-defined time-domain signals symbolically and graphically, with options to explore magnitude and phase plots.

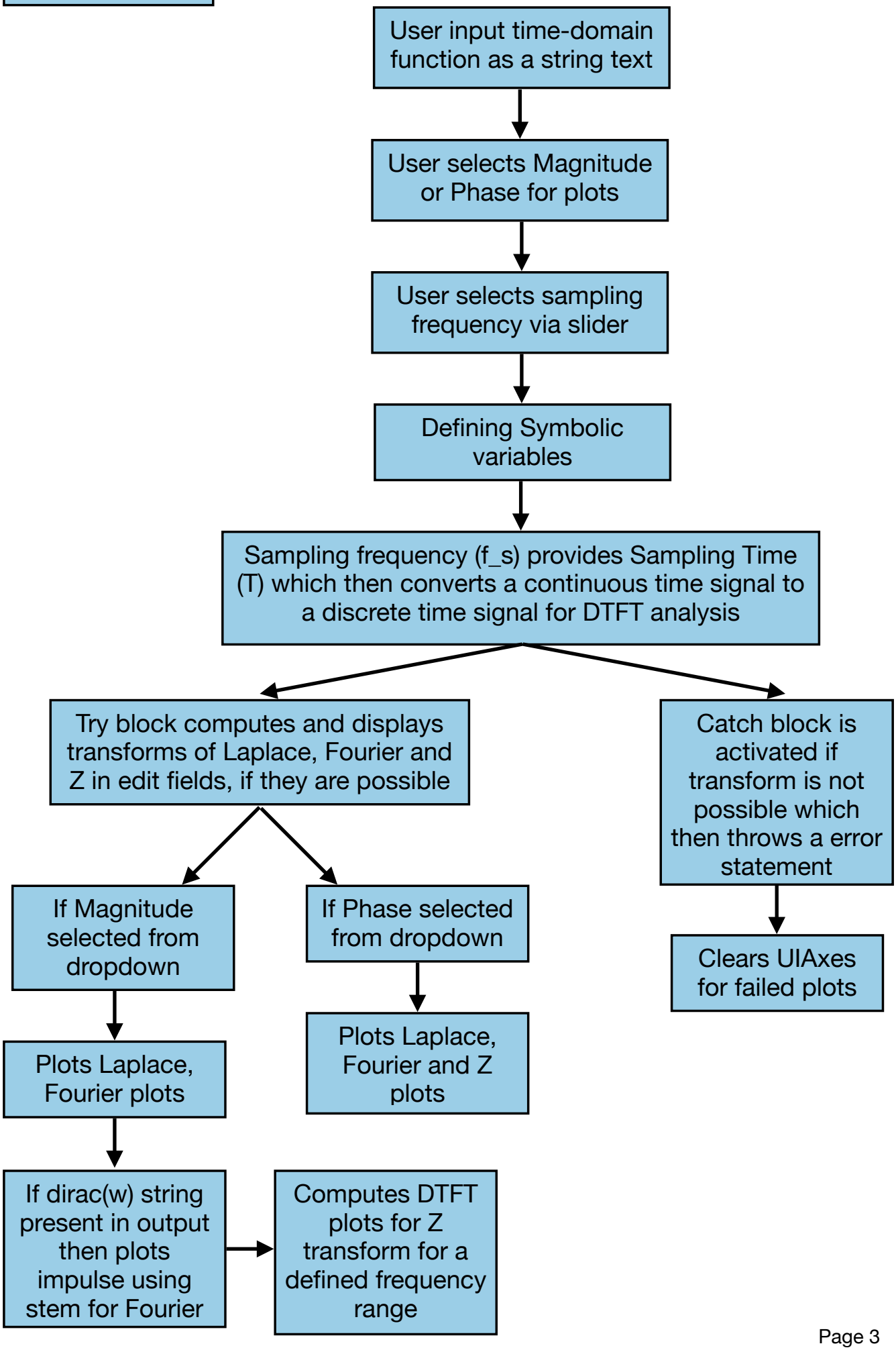
DESCRIPTION

This application helps users to enter any time-domain function and calculate its Laplace, Fourier, and Z-transforms symbolically. It plots the magnitude or phase of each transform versus a range of frequencies, assisting users in visualising and comprehending the signal's behavior in the various transform domains. A slider is available for adjusting the sampling frequency used during the calculation of the Z-transform, which determines the resolution of the frequency response.

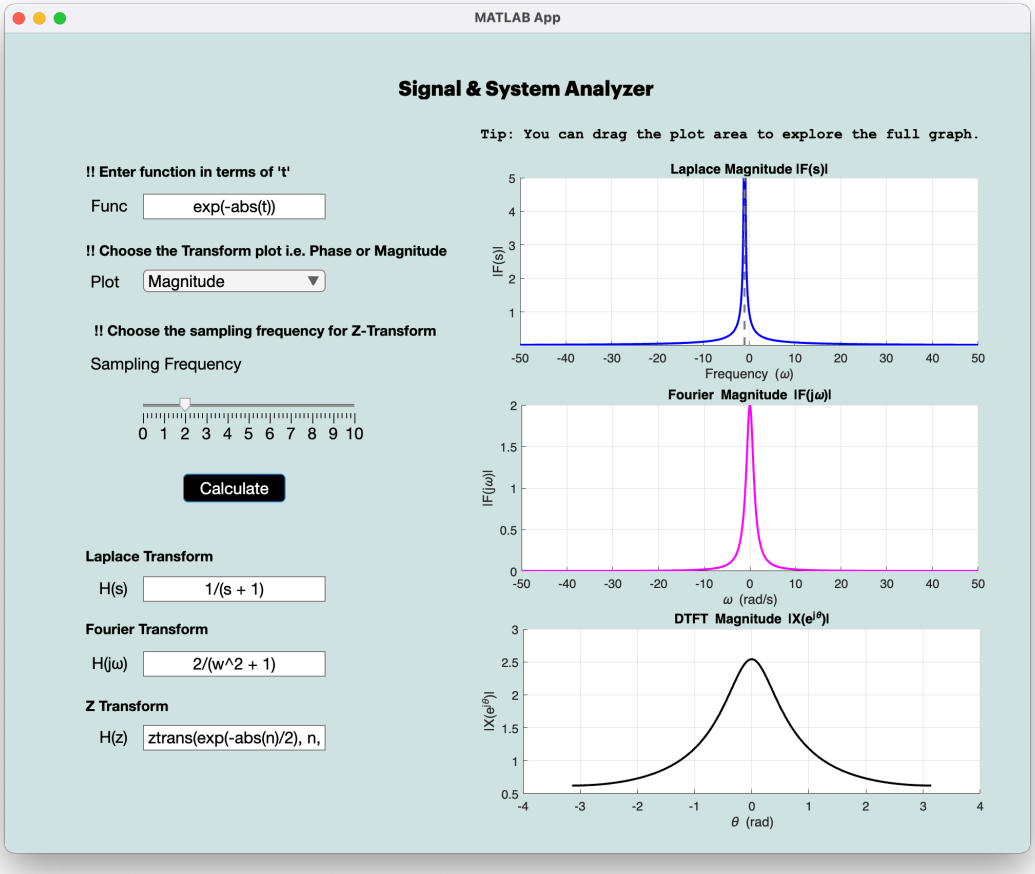
The application is made to be versatile and process a broad variety of user-specified inputs. It correctly presents frequency-domain properties for continuous and discrete-time signals, and thus it can be applied in analyzing features such as frequency content, system response, and signal stability. The Laplace transform offers information on system dynamics and control behavior. The Fourier transform reveals the distribution of signal energy in frequencies, a critical application in signal processing and communications. The Z-transform is applied for digital and discrete-time system analysis.

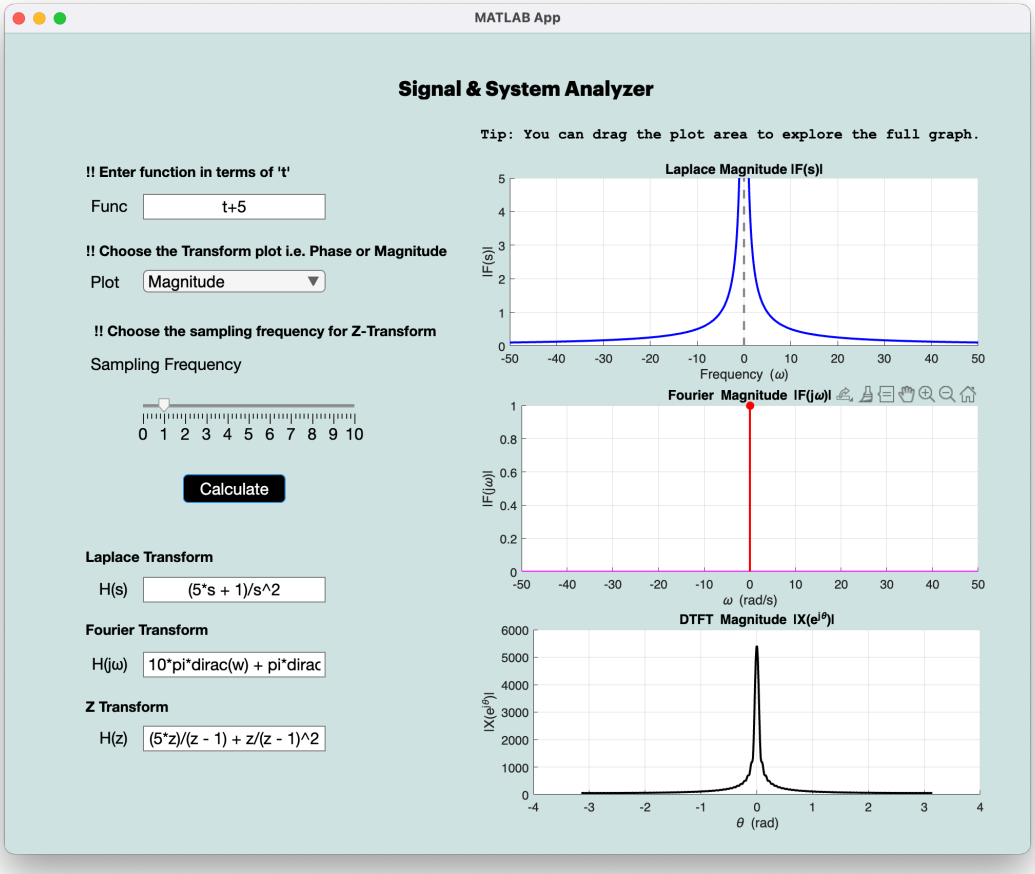
To handle constraints in MATLAB's Symbolic Math Toolbox, particularly for undefined transforms, the app employs a numerical DTFT method to estimate the Z-transform on the unit circle. This guarantees smooth and stable plots for arbitrary user inputs. Because symbolic plotting likewise does not accurately display impulses such as dirac functions, the app identifies such elements in symbolic output and displays them manually in the form of stem plots. This allows for the user to visually see the full frequency behavior of the signal, including ideal or theoretical elements.

FLOW CHART

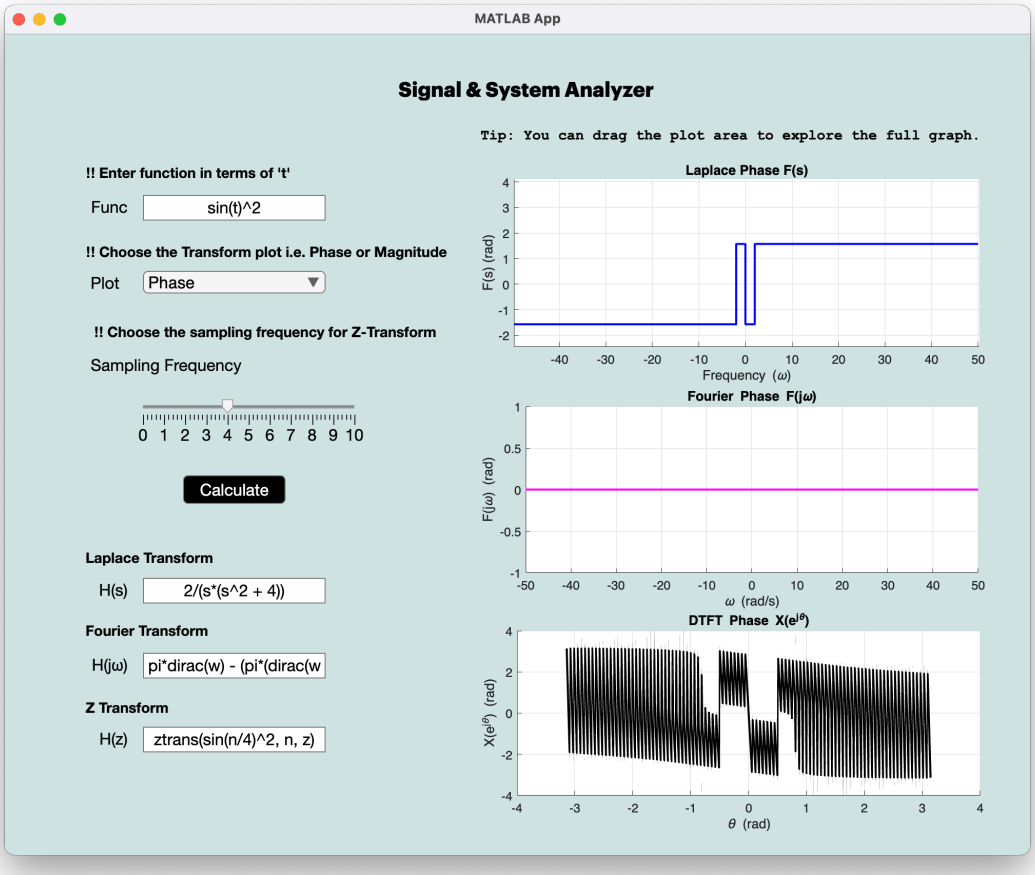

User input time-domain function as a string text
User selects Magnitude or Phase for plots
User selects sampling frequency via slider
Defining Symbolic variables
Sampling frequency (f_s) provides Sampling Time (T) which then converts a continuous time signal to a discrete time signal for DTFT analysis
Try block computes and displays transforms of Laplace, Fourier and Z in edit fields, if they are possible
Catch block is activated if transform is not possible which then throws a error statement
If Magnitude selected from dropdown
If Phase selected from dropdown
Clears UIAxes for failed plots
Plots Laplace, Fourier plots
Plots Laplace, Fourier and Z plots
If dirac(w) string present in output then plots impulse using stem for Fourier
Computes DTFT plots for Z transform for a defined frequency range

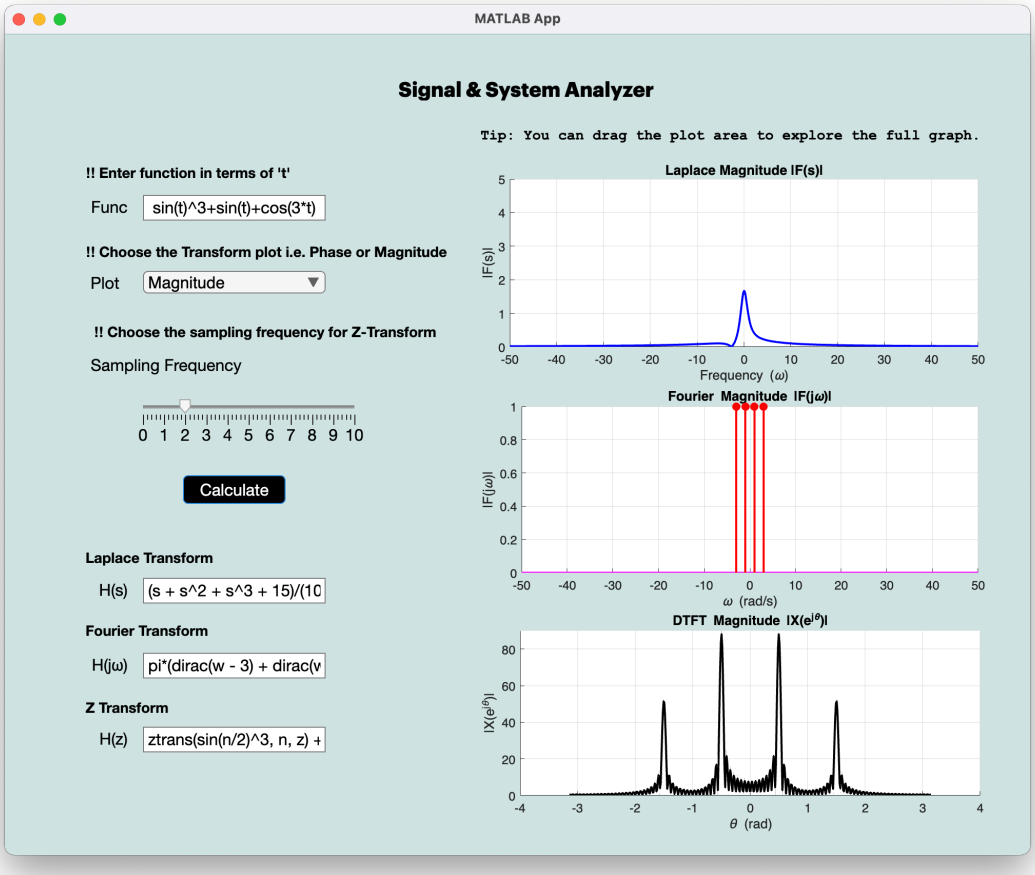
SCREENSHOTS





SCREENSHOTS





CONCLUSION

This app is intended to support students having difficulties with calculation and comprehension of Laplace, Fourier, and Z-transforms. By providing a facility for entering any time-domain function, the app performs corresponding transforms symbolically and displays precise visualizations of their magnitude and phase responses. It closes the gap between practice and theoretical comprehension, allowing learners to gain firm knowledge on signal behavior both in continuous and discrete domains. The app also rectifies typical constraints of MATLAB symbolic plotting by utilizing numerical DTFT for the Z-transform and direct impulse rendering for Fourier plots to guarantee completeness of visualization.

This tool is particularly convenient in courses involving signal processing, control systems, and communication engineering where transform-domain analysis plays a crucial role. It aids conceptual understanding, supports self-study, and may be utilized as an ancillary teaching aid in classrooms.