Course: Introduction to Signal Processing Toolbox in MATLAB

COURSE DESCRIPTION

Programming and problem solving using MATLAB. Emphasizes the systematic development of algorithms and programs. Topics include iteration, functions, arrays and vectors, strings, recursion, algorithms, object-oriented programming, and MATLAB graphics. Assignments are designed to build an appreciation for complexity, dimension, fuzzy data, inexact arithmetic, randomness, simulation, and the role of approximation. NO programming experience is necessary; some knowledge of Calculus is required.

Expected Outcomes

- **Be fluent in the use of procedural statements--assignments, conditional statements, loops, function calls--and arrays.**
- **Be able to design, code, and test small MATLAB programs that meet requirements expressed in English. This includes a basic understanding of top-down design.**
- **Have knowledge of the concepts of object-oriented programming as used in MATLAB: classes, sub classes, properties, inheritance, and overriding.**
- **Have knowledge of basic sorting and searching algorithms.**
- **Have knowledge of basic vector computation.**
- **Have a working familiarity with graphics tools in MATLAB.**
- **Have a good basics in Signal Processing thermos**
- **Have a deep exposure to Signal Processing Toolbox**

SYLLABUS

BASICS

1. **Introduction TO MATLAB**
2. **Programming basics**
3. **Conditionals**
4. **Nested conditionals**
5. **logical operators**
6. **Iteration: for**
7. **Iteration: while**
8. **Developing algorithms;**
9. **nested loops**
10. **User-defined functions**
11. **Executing a user-defined function**
12. **Discrete vs. continuous;**
13. **plotting**
14. **Probabilities and Averages;**
15. **vectors**
16. **Simulation;**

17. color computation, linear interpolation

18. 2-d Arrays—matrix

19. Matrix examples

20. Working with Images

21. Characters and strings

22. Cell arrays

23. working with numeric/text data (file I/O)

24. Structures and structure arrays

25. Objects and Classes

26. Array of objects, constructor that handles variable number of args

27. Why OOP? Private vs. public, Inheritance

28. Recursion

29. Sorting and Searching

30. Divide and Conquer

SIGNAL PROCESSING TOOLBOX

1. Introduction to discrete linear systems

[1] Discrete time signals.
[2] Special sequences.
[3] Shift invariance.
[4] Stability and causality.
[5] Impulse response.
[6] Difference equations.
[7] Lab exercises

2. Discrete-Time Fourier Transform and Linear Time Invariant Systems

[1] Transform definitions.
[2] Theorems.
[3] Frequency response of linear time invariant systems.
[4] Phase and group delays.
[5] Matlab computations.
[6] Lab exercises

3. The Z transform

[1] Z-transforms by summation of left, right, and two-sided sequences.
[2] Regions of convergence and Z-transform properties.
[3] Inverse Z-transform.
[4] Lab exercises

4. Properties of digital filters

[1] Averaging filter.
[2] Recursive smoother.
[3] First-order notch filter.
[4] Second-order unity gain resonator.
[5] All-pass filters.
[6] Comb filters.
[7] Equalization filters.
[8] Group delay, linear phase, all-pass, minimum phase
[9] Lab exercises

5. Fourier transforms, sampling – Part I

[1] Fourier transform review.
[2] Sampling continuous-time signals: the sampling theorem.
[3] Aliasing.
[4] Re-sampling digital signals.
[5] Midterm review.
[6] Lab exercises

6. Fourier transforms, sampling – Part II

[1] A/D conversion and quantization
[2] D/A conversion
[3] Polyphase decomposition
[4] Polyphase DFT filterbanks
[5] Bandpass sampling
[6] Lab exercises

7. The discrete Fourier transform

[1] Definition of DFT and relation to Z-transform.
[2] Properties of the DFT.
[3] Linear and periodic convolution using the DFT.
[4] Zero padding, spectral leakage, resolution and windowing in the DFT.
[5] Lab exercises

8. The fast Fourier transform

[1] Decimation in time FFT.
[2] Decimation in frequency FFT.
[3] Digital filter design
[4] Lab exercises

9. Finite impulse response (FIR) filters

[1] Window design techniques.
[2] Kaiser window design technique.
[3] Equiripple approximations.
[4] Lab exercises

10. Infinite impulse response (IIR) filters

[1] Bilinear transform method.
[2] Examples of bilinear transform method.
[3] Lab exercises

13. Structures and properties of FIR and IIR filters and review

[1] IIR - Direct, parallel and cascaded realizations.
[2] FIR – Direct and cascaded realizations.
[3] Coefficient quantization effects in digital filters
[4] Final Project