MATLAB PROGRAMMING FOR NUMERICAL COMPUTATION

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INTENDED AUDIENCE

This is an introductory course, targeted towards scientists and engineers interested in using MATLAB programming for numerical computations. Examples taken in this course will be of generic interest to a wide range of students.This is a hands-on (like a laboratory) elective course. Intended audience include undergraduates, people with BE / ME / MS / MSc degrees; The course may be useful for PhD students also.

PRE-REQUISITES

The students for this course are expected to know basics of linear algebra and calculus, at 12th standard level. These are also covered in Introductory Math course for Engineers (typically done in first year).

This course is intended to be practical (laboratory) course. Some prior background in programming will be useful, though not required. Likewise, students who have either completed or are currently doing "Numerical Methods" / "Computational Techniques" will find it easier to follow this course. Theoretical aspects of methods covered in this lab can be found in NPTEL course on "Numerical Methods for Engineers" (https://nptel.ac.in/courses/127106019).

ABOUT THE COURSE

MATLAB is a popular language for numerical computation. This course introduces students to MATLAB programming, and demonstrate it's use for scientific computations. The basis of computational techniques are expounded through various coding examples and problems, and practical ways to use MATLAB will be discussed. By the end of this course, students would:

1.Learn basics of MATLAB programming
2.Get introduced to numerical methods for engineering problems
3.Will be able to use MATLAB to solve computational problems

SOFTWARE USED:

We will use MATLAB in this course. Course lectures, practice problems and assignments will use MATLAB.

MATLAB Online is a fully-featured browser-based version of MATLAB. With support from MathWorks, access to MATLAB Online is provided free-of-cost to all the enrolled students for the duration of this course.

ABOUT THE COURSE:

Prof. Niket Kaisare is a Professor of Chemical Engineering in IIT-Madras. He works in the area of modeling, design and control for energy applications. He has over ten years of research/teaching experience in academia, and three-year experience in Industrial R&D. He uses computational software, including MATLAB, FORTRAN, Aspen and FLUENT extensively in his research and teaching.
Faculty web-page: http://www.che.iitm.ac.in/~nkaisare/

COURSE PLAN:

The course will be covered in twelve modules. Various aspects of MATLAB programming for numerical computation will be covered in these modules, with each module dedicated to an equivalent numerical topic. There will be self-study problems and graded assignment problems given each week, which are to be solved using MATLAB. The course plan is:

1.Introduction to MATLAB Programming: This module will introduce the students to MATLAB programming through a few examples. Students who have used MATLAB are still recommended to do this module, as it introduces MATLAB in context of how we use it in this course

2.Building your Code with MATLAB: This module covers MATLAB Script and Function files, loops, execution control, best-practices for MATLAB functions and tips on how to debug a MATLAB code.

3.Approximations and Errors: Taylor's / Maclaurin series expansion of some functions will be used to introduce approximations and errors in computational methods

4.Linear Equations: The focus of this module is to do a quick introduction of most popular numerical methods in linear algebra, and use of MATLAB to solve practical problems.

5.Nonlinear Equations: After introduction to bisection rule, this module primarily covers Newton-Raphson method and MATLAB routines fzero and fsolve.

6.Numerical Differentiation and Integration: Methods of numerical differentiation and integration, trade-off between truncation and round-off errors, error propagation and MATLAB functions for integration will be discussed.

7.Ordinary Differential Equations (ODE): Explicit ODE solving techniques in single variable will be covered in this module.

8.ODE-IVP in Multiple Variables: This module will cover ODE solving in multiple variables, stiff systems, and practical problems. The importance of ODEs in engineering is reflected by the fact that two modules are dedicated to ODEs.

9.Regression and Interpolation: The focus will be practical ways of using linear and nonlinear regression and interpolation functions in MATLAB.

10.ODE-BVP and DAE: ODE-Boundary Value Problems; Differential Algebraic Equations

11.Partial Differential Equations (PDEs): Practical ways of solving Hyperbolic and Parabolic PDEs

12.Bringing it all together: Optimization andSolving interesting computational problems by bringing together multiple concepts