Notes for lecture 4

1. Date: May 2nd. This lecture is based on Sections 3.1 and 3.2 of Chapter 3 of the main textbook (see Chapter3.1.pdf and Chapter3.2.pdf file)
2. Section 3.1 (see Chapter3.1.pdf and Lecture4.pdf) introduce linear differential equation (with constant coefficients) of 2nd order. The content is simple and the key points are as follows.
    a. For a 2nd order linear equation, there are two independent solutions and the general solution is constructed as a linear combination of these two solutions.
    b. When establishing independent solutions, we use the so-called characteristic equation. The latter is just a quadratic equation (with two solutions). The idea is very similar to what we studied in Linear Algebra when dealing with eigenvalues.
    c. Section 3.1 consider characteristic equations whose solution are distinct real numbers (not imaginary numbers).
3. Section 3.2 (see Chapter3.2.pdf and Lecture4.pdf). Here, we consider equations whose coefficients are not constant but function of x (or t, depending on the notation employed).
    a. A new concept (linear operator) is introduced. The linear operator takes a function (on the input) and produce another function (on the output). In our case, the simplest operator D does the differentiation of functions.
    b. This section rigorously explains why summation of two solutions is also a solution (principle of superposition), and why (and under what conditions) such a linear combination produces a general solution.
    c. When checking when two solutions are independent or not we use a special determinant (please brush up your knowledge of Linear Algebra) called Wronskian.
4. Explanation of the content is accompanied by examples. In addition, you can look at the sample problems (see SampleProblems4.pdf file)
5. Additional Internet resources
    a. A short video from Khan Academy on linear homogeneous equations
       https://www.khanacademy.org/math/differential-equations/second-order-differential-equations#linear-homogeneous-2nd-order
       is recommended.
6. The deadline for submitting homework, Assignment 4 (refer to Assignment4.pdf) is May 9, 13:00.