MAT 3110: ENGINEERING MATHEMATICS II

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Course Description

The content of course can be broadly divide into four mathematics topics.

0.1 Ordinary Differential Equations

An ordinary differential equation (ODE) is a differential equation containing one or more functions of one independent variable and the derivatives of those functions. The term ordinary is used in contrast with the term partial differential equation which may be with respect to more than one independent variable.

A linear differential equation is a differential equation that is defined by a linear polynomial in the unknown function and its derivatives, that is an equation of the form

$$a_0(x)y + a_1(x)y' + a_2(x)y'' + \cdots + a_n(x)y^{(n)} + b(x) = 0$$

where $a_0(x)$, ..., $a_n(x)$ and $b(x)$ are arbitrary differentiable functions that do not need to be linear, and y',... ,$y^{(n)}$ are the successive derivatives of the unknown function y of the variable x. (extract from wikipedia)

In MAT 2110, you were taught (of must have been taught) the following:

1. Solving first order differential equations of the following types
   - linear differential equation(by using an integrating factor)
   - separable differential equations
   - exact diffirential equations
   - Bernoulli differential equations
2. Solving second order linear differential equations with constant coefficients by taking the following steps 1. Solving the homogeneous second order linear differential equations by using the characteristic polynomial 2. Using the solution of the non-homogeneous second linear differential equations by either using the method of undetermined coefficients of the method of variation of parameters.

In this course, you will be taught how to solve to linear differential equations with variable coefficients (of any order).

1. Using Laplace transforms to solve ordinary differential equations.
2. Solving Systems of ordinary differential equations
3. Finding series solutions to ordinary differential equations.
4. Solving Euler equations
5. Frobenius method for solving Euler equations

0.2 Partial Differential Equations

From the mathematics courses you have done at UNZA, you are meeting this topic for the first time.

A partial differential equation (PDE) is a differential equation that contains beforehand unknown multivariable functions and their partial derivatives. PDEs are used to formulate problems involving functions of several variables, and are either solved by hand, or used to create a computer model. (extract from wikipedia)

In this course, you will be taught fourier transforms and integrals and we can use these how to solve to linear partial differential equations.

0.3 Advanced Calculus

Calculus is the mathematical study of continuous change.

It has two major branches, differential calculus (concerning instantaneous rates of change and slopes of curves), and integral calculus (concerning accumulation of quantities and the areas under and between curves). These two branches are related to each other by the fundamental theorem of calculus. (extract from wikipedia)

In MAT 1100, you were introduced to calculus using functions of a single variable. In this course, we generalise to functions of several variables.

Some of the subtopics we will cover are

1. 3-Dimensional Space
2. Partial Derivatives
3. Applications of Partial Derivatives
4. Multiple Integrals
5. Line Integrals
6. Surface Integrals

0.4 Introduction to Probability and Statistics

Probability is the measure of the likelihood that an event will occur. Probability quantifies as a number between 0 and 1, where, loosely speaking, 0 indicates impossibility and 1 indicates certainty. The higher the probability of an event, the more likely it is that the event will occur. A simple example is the tossing of a fair (unbiased) coin. Since the coin is fair, the two outcomes

("heads" and "tails") are both equally probable; the probability of "heads" equals the probability of "tails"; and since no other outcomes are possible, the probability of either "heads" or "tails" is 1/2 (which could also be written as 0.5 or 50%). (extract from wikipedia)

Statistics is a branch of mathematics dealing with data collection, organization, analysis, interpretation and presentation. In applying statistics to, for example, a scientific, industrial, or social problem, it is conventional to begin with a statistical population or a statistical model process to be studied. Populations can be diverse topics such as "all people living in a country" or "every atom composing a crystal". Statistics deals with all aspects of data including the planning of data collection in terms of the design of surveys and experiments. (extract from wikipedia)

Some of the subtopics in this course are,

1. Probability
    - Introduction to probability:
    - Expectations of random variables,
    - discrete random variables; Binomial, Poisson.
    - Continuous random variables; Uniform, Exponential, Normal.
2. Statistics
    - Estimation and sampling distributions: Point estimates for mean, proportions, difference of means and proportions and their sampling distributions, confidence interval for mean, and proportions, difference of means and proportions, variance and ration of variances.
    - Statistical hypothesis testing: Definition of statistical hypotheses, tests about mean, proportions, and differences of means/proportions for both small and large sample sizes. Type I and II errors, Tests of hypothesis about variance and ratio of variance, and tests of independence and goodness of best fit.

Reading Materials

0.5 Prescribed Readings

1. Kreyzig E., (2011) Advanced Engineering Mathematics. 10th Ed. John Willey and Sons. ISBN: 0 470 45836 5
2. Mclave J.T., and Sincich T., (2012) Statistics. Pearson Education Ltd., ISBN: 0 321 75593 3

0.6 Recommended Readings

1. Wylie R.C. and Barret L.C., (1995) Advanced Engineering Mathematics. McGraw-Hill. Company. ISBN: 0 070 72206 4
2. Grossman S.T., (1996) Multivariable Calculus, Linear Algebra and Differential Equations, 3rd ed. HBL Publishers. ISBN: 0 155 64751 2

3. Stewart J., (2012) Calculus. International edition, 7th edition, Brooks/Cole, Cengage Learning ISBN: 0 538 49884 5

4. Walpole R.E., (1984) Introduction to statistics. Macmillan. ISBN: 0 024 24150 4

Course Objectives

At the end of the course, students should be able to:

1. Find solutions of ordinary differential equations with variable coefficients, systems of first order ordinary differential equations, and partial differential equations
2. Find and apply the Laplace transform, Fourier series, Fourier integral, and Fourier transform of a given function.
3. Sketch, identify quadratic surfaces, and write equations of quadratic surfaces, tangent planes, and normal lines to a surface at a given point.
4. Compute double, triple, surface, and line integrals.
5. State and apply Fundamental theorem of line integrals, GreenâĂŹs theorem, StokeâĂŹs theorem, and Divergence theorem.
6. Define and apply basic concepts of probability.
7. Organise, summarise, and analyse data sets.

Assessments

If everything goes according to plan, assessment in this course will be as follows

Assessment	Contribution towards final grade
10 Assignments	2%
3 Quizes	8%
3 Tests	20%
Final Exam	70%