Course Outline

MATH 3160 – 01
Differential Equations 2 (3,1.5,0)
Fall 2019

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Calendar Description

This course has three parts. The first part examines some methods for solving ordinary differential equations. Power series methods are applied to obtain solutions near ordinary points and regular singular points, and the real Laplace transform is discussed. The second part deals with Sturm-Liouville boundary-value problems, Fourier series, and other series of eigenfunctions, including Fourier-Bessel series. The final part is an introduction to boundary-value problems involving partial differential equations, primarily the heat equation, the wave equation and Laplace's equation, with applications in physics. The method of separation of variables is used.

Education Objectives/Outcomes

On completion of the course students will be expected to:

1. construct power series solutions of 2nd-order linear differential equations with polynomial coefficients.

2. classify singular points of linear differential equations, and construct a power series solution about a regular singular point.

3. use the Laplace transform and its inverse to solve linear differential equations involving discontinuous and impulsive (Dirac delta) forcing functions.

4. calculate the Fourier series, cosine series and sine series of a piecewise-continuous function.

5. calculate eigenfunctions of a Sturm-Liouville problem and state their orthogonality properties.

6. construct Fourier series solutions of classical homogeneous and non-homogeneous boundary-value problems, including the heat equation, the wave equation and Laplace's equation, in both rectangular and polar coordinate systems.

Prerequisites

Math 2240 (Differential Equations 1) or equivalent.

Texts/Materials

Zill, *Differential Equations with Boundary-Value Problems*, 9th Edition, Nelson, 2018.

Student Evaluation

Weekly assignments/quizzes ($\times 8$) 15%
Midterm exams ($\times 2$) 40%
Final exam 45%

In the event a student misses an exam, a mark of zero will be given unless the student contacts the instructor prior to the exam, informing the instructor of the particular situation. Students are responsible for checking the final examination schedule which shall be posted each semester by the Registrar, and for advising the Registrar of any conflicts within the schedule. Attendance at a scheduled final examination is mandatory, and the responsibility is on the student to seek remedy for a missed final exam.

Students who require special accommodation due to a disability are encouraged to contact Accessibility Services.

Attendance Regulations

A registered student who does not attend the first two events (e.g., lectures/labs/etc.) of the course and who has not made prior arrangements acceptable to the instructor may, at the discretion of the instructor, be considered to have withdrawn from the course and have his/her course registration deleted. A registered student is expected to attend a minimum of 90% of lectures and seminars for which he/she is enrolled. In the case of deficient attendance without cause, a student may, on recommendation of the instructor to the instructors Dean or Chairperson, be withdrawn from a course. Admission to a lecture or seminar may be refused by the instructor for lateness, class misconduct, or failure to complete required work.

Academic Integrity Policy

TRU students are required to comply with the standards of academic integrity set out in Student Academic Integrity policy (ED 5-0), available at TRU website. Cheating, academic misconduct, fabrication, and plagiarism could result in failure of a course or even suspension from TRU.

Prior Learning Assessment and Recognition/Challenges

Students may receive credit for Prior Learning Assessment and Recognition (PLAR) by writing a challenge examination designed by a qualified specialist approved by the Department of Mathematics and Statistics. More information can be obtained from the Office of the Registrar.

Use of Technology

A scientific calculator is allowed. Graphing calculators are not permitted on tests or quizzes. Cell phones are to be turned off and not used during class.

Math Help Centre

All students are welcome to consult with a math tutor on a drop-in basis, free of charge, at the Math Help Centre, which is located in House of Learning Room 304. More information is available on the following webpage: https://www.tru.ca/science/programs/math/math_help_centre.html

Course Topics

1. **Power Series Solutions** (2 weeks)
   Review of power series
   Power series solutions
   Cauchy-Euler equations
   Classification of singular points
   Series solutions about a regular singular point
   Bessel's equation and Bessel functions

2. **Laplace Transform** (2.5 weeks)
   Introduction to the Laplace transform Section
   Inverse transform and transforms of derivatives
   Translation theorems and step functions
   Derivatives of transforms, convolution
   Dirac delta function
   Linear systems

3. **Orthogonal Functions and Fourier Series** (2.5 weeks)
   Orthogonal functions
   Calculation of Fourier series
   General facts about Fourier series
   Fourier cosine and sine series
   Regular Sturm-Liouville problem
   Series of eigenfunctions

4. **Boundary-value Problems in Rectangular Coordinates** (3.5 weeks)
   Separable partial differential equations
   The heat equation
   The wave equation
   Laplace's equation
   Nonhomogeneous equations and boundary conditions
   Use of generalized Fourier series
   Problems in higher dimensions

5. **Boundary-value Problems in Other Coordinate Systems** (1.5 weeks)
   Laplace's equation in polar coordinates
   Problems involving Bessel functions