THOMPSON RIVERS UNIVERSITY | Mathematics and Statistics

Course Outline

MATH 2670 – 01
Calculus 4 for Engineering (3,1.5,0)
Winter 2020

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Calendar Description

Students study vector calculus, ordinary differential equations and Fourier series, all of which are important as basic knowledge for engineers. Topics in vector calculus include line integrals, conservative fields and path independence, Green's theorem, surface integrals, Stokes' theorem and the divergence theorem. In their study of differential equations, students learn solution methods such as variation of parameters, reduction of order, power series solutions about ordinary points and the Laplace transform.

Education Objectives/Outcomes

On completion of the course students will be expected to:

- Calculate line integrals and apply them to problems in physics and engineering, such as finding the total mass of a wire of variable density, the work done on an object by a force field as the object moves along a curve, and the circulation of a vector field around a closed curve.
- Determine whether a vector field is conservative and, in cases where the field is conservative, apply the fundamental theorem for line integrals.
- Apply Green's theorem when appropriate.
- Calculate the curl and divergence of a vector field, and verify identities involving the gradient operator (e.g., the curl of a divergence is zero, the divergence of a curl is zero).
- Represent surfaces in parametric form.
- Use a parametric representation for a surface to calculate the area of the surface and to evaluate surface integrals.
- Apply surface integrals to problems in physics and engineering, such as finding the total mass of a surface of variable density and the flux of a vector field through a surface.
- Apply Stokes' theorem and the divergence theorem when appropriate.
- Apply the method of separation of variables to find general solutions of separable, first-order, ordinary differential equations and to solve initial value problems involving such equations.
- Solve linear, first-order differential equations using integrating factors.
- Apply first-order differential equations to problems such as chemical mixing problems.
- Determine when a first-order differential equation is exact and find general solutions of exact equations.
- Solve logistic-type equations and relate them to population models.

- Solve linear, homogeneous, constant-coefficient, second-order differential equations by finding characteristic roots and handling these roots correctly in all cases (real roots, complex roots, repeated real roots).
- Solve linear, homogeneous, constant-coefficient differential equations of order greater than two in cases where the characteristic roots can be determined.
- Solve linear, non-homogeneous, constant-coefficient differential equations using the methods of undetermined coefficients and variation of parameters.
- Apply second-order differential equations to solve problems involving mechanical oscillations and resonance.
- Apply second-order differential equations to solve problems involving simple electrical circuits.
- Calculate Laplace transforms and inverse transforms for standard, basic functions and apply them to solve initial value problems involving linear, constant-coefficient differential equations and systems of such equations.
- Use partial fractions when appropriate as a tool in the calculation of inverse Laplace transforms.
- Calculate the Laplace transform of a convolution, and express the inverse transform of a product as a convolution.
- Calculate the Laplace transform of a periodic function.
- Use a delta function when appropriate and calculate its Laplace transform.
- Apply power series to find the general solution of a differential equation near an ordinary point.
- Calculate Fourier series (using sines and cosines) for periodic functions.
- Calculate Fourier sine and cosine series.

Prerequisites

MATH 2650 (Calculus 3 for Engineering).

Texts/Materials

- James Stewart, *Multivariable Calculus*, 8th Edition, Cengage Learning, 2016.
- Zill, *Differential Equations with Boundary Value Problems*, 9th Edition, Nelson, 2018.

Student Evaluation

Assignments and quizzes 20%
Midterm exam #1 ..... 20%
Midterm exam #2 ..... 20%
Final exam 40%

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. **Vector Fields and Integration on Curves and Surfaces ..... Stewart, Ch. 16**
   Vector fields (review)
   Line integral
   Path independence and conservative fields
   Green's theorem
   Curl and divergence (review)
   Parametric surfaces and their areas
   Surface integrals
   Stokes' Theorem
   Divergence Theorem
2. **First-Order Differential Equations ..... Zill, Ch. 2**
   Slope fields and solution curves
   Separable equations
   Linear first-order equations
   Substitution and exact equations
   Autonomous differential equations: stability of equilibria
3. **Higher-Order Linear Equations ..... Zill, Ch. 4**
   General solution of linear equations
   Homogeneous equations with constant coefficients
   Mechanical vibrations
   Non-homogeneous equations and underdetermined coefficients
4. **Physical Models ..... Zill, Ch. 5**
   Forced oscillations and resonance
   Electrical circuits
5. **Power Series Methods ..... Zill, Ch. 6**
   Series solution near an ordinary point
6. **Laplace Transform Methods ..... Zill, Ch. 7**
   Transformation of initial value problems
   Translation and partial fractions
   Derivatives, integrals and products of transforms
   Periodic and piecewise-continuous functions
   Impulses and the Dirac delta function
7. **Fourier Series ..... Zill, Ch. 11**
   Periodic functions and Fourier series
   General Fourier series and convergence
   Fourier sine and cosine series
   Applications of Fourier series