Course Outline

MATH 2650 – 01
Calculus 3 for Engineering (3,1.5,0)
Fall 2019

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Calendar Description

Students see how the concepts of single-variable calculus are extended to higher dimensions by using vectors as variables. Topics include the analytic geometry of lines, planes and surfaces; calculus of curves in two and three dimensions, including arc length and curvature; calculus of scalar-valued functions of several variables, including the gradient, directional derivatives and the Chain Rule; multi-variable Taylor approximations; Lagrange multipliers and optimization problems; double and triple integrals in rectangular coordinates and in other coordinate systems, and general variable changes in integrals; vector fields and gradient fields, and the curl and divergence of vector fields.

Education Objectives/Outcomes

On completion of the course students will be expected to:

- Write equations for lines, planes, cylinders, spheres, cones, ellipsoids, paraboloids and hyperboloids in rectangular coordinates, and identify these geometric objects from their equations.
- Describe lines and curves in the plane and in space by means of suitable parametric equations.
- Calculate derivatives and integrals of vector-valued functions of a single variable, and interpret the derivatives as tangent vectors to corresponding parametric curves.
- Calculate arc length and curvature of curves described parametrically, and calculate the principal unit normal vector to a curve.
- Calculate the velocity, speed and acceleration functions for an object moving along a curve, and interpret derivatives of vector-valued functions in this way.
- Calculate partial derivatives of scalar-valued functions of multiple variables and interpret these as rates of change.
- Find equations for tangent planes to the graphs of scalar-valued functions of two variables.
- Find and apply linear approximations to scalar-valued functions of multipl e variables, using standard function notation and also using the notation of differentials.
- Write the Chain Rule for partial derivatives of composite functions involving multiple variables, and use the Chain Rule for computations.
- Calculate directional derivatives, gradients and level curves/surfaces, and interpret the gradient as the direction of maximum increase of a function, which is perpendicular to the level curves/surfaces.
- Find critical points for functions of multiple variables, and apply the Second Derivative Test to determine whether critical points correspond to maxima, minima or saddle points.

- Calculate Taylor polynomials of degree two for functions of two variables.
- Solve optimization problems using Lagrange multipliers.
- Evaluate double integrals in rectangular and polar coordinates.
- Evaluate triple integrals in rectangular, cylindrical and spherical coordinates.
- Apply integrals to problems in physics and engineering, such as finding the total mass of an object with a variable density, finding the centre of mass of an object and its moment of inertia about an axis, and calculating volumes of objects bounded by curved surfaces.
- Evaluate double and triple integrals using the general formula for a change of variables.
- Represent vector fields by plots showing some vectors in the field as arrows.
- Determine whether a vector field is a gradient field.
- 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 and the divergence of a curl is zero).

Prerequisites

MATH 1230 (Calculus II) and MATH 1300 (Linear Algebra) or equivalent.

Texts/Materials

Required:
James Stewart, *Multivariable Calculus*, 8th Edition, Cengage Learning, 2016.

Student Evaluation

Assignments and quizzes 15%
Midterm exam #1 .... 20%
Midterm exam #2 .... 20%
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. **Vectors and Analytic Geometry** .... **Ch. 12**
   Rectangular coordinates in three dimensions (review)
   Vectors in three dimensions (review)
   Equations of lines and planes
   Cylinders and quadric surfaces

2. **Vector Functions** .... **Ch. 13**
   Vector functions and space curves
   Derivatives and integrals of vector functions
   Arc length and curvature
   Motion in space: velocity & acceleration

3. **Partial Derivatives** .... **Ch. 14**
   Functions of several variables
   Partial derivatives
   Tangent planes and linear approximations
   The chain rule
   Directional derivatives and the gradient vector
   Maximum and minimum values
   Lagrange multipliers

4. **Multiple Integrals** .... **Ch. 15**
   Double integrals over rectangles
   Double integrals over general regions
   Double integrals in polar coordinates
   Applications of double integrals
   Surface area
   Triple integrals
   Triple integrals in cylindrical coordinates
   Triple integrals in spherical coordinates
   Change of variables in multiple integrals

5. **Vector Fields** .... **Ch. 16**
   Vector fields
   Curl and divergence