THOMPSON RIVERS UNIVERSITY

Course Outline

Department of Mathematics & Statistics
Faculty of Science

MATH 2650 – 3 Credits
Calculus 3 for Engineering (3,1.5,0)
Fall, 2018

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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 multiple 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 Chair 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 20%
Midterm exam #1 ..... 20%
Midterm exam #2 ..... 20%
Final exam 40%

Missed quizzes and exams will result in a mark of zero unless the student provides a valid reason and receives prior approval from the instructor.

NOTE: The final examination will be written at a time between Dec. 3 and Dec. 15, as scheduled by the Registrar's Office. The examination could be scheduled at any time during this period. Students should plan accordingly.

For detailed information on policies and regulations regarding examinations please refer to the TRU calendar.

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