Math 254N MULTIVARIABLE AND VECTOR CALCULUS **Spring 2018**

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Web Page: http://math.oit.edu/~watermang/ There is a link there to a page for our class. (A search for waterman oit will find you the web page as well.) At the web page you can find links to auxiliary resources, as well as a link to a class schedule that is updated daily. The schedule will guide you to suggested reading and videos, list suggested or mandatory assignments, and announce quizzes.

Office Hours: 9-10:30 MTWF. You are also welcome to drop in any time to see if I am around - if I am I can usually take some time to help you. **I can also make appointments for other times**.

Text: The *optional* textbook is **Calculus: Early Transcendentals** by Briggs and some others, available in the bookstore. This is the book that has been used for 251 and 252 last year. We will also use a free text that can be found online, as well as some notes that I wrote myself.

Grading: Your grade will be based on your scores on assignments, quizzes and exams.

- *Assignments:* Assignments will be given once or twice a week. Each assignment is due at the start of class the next class meeting after it was assigned - **credit will not be given for late assignments**, unless necessitated by a school activity and prior arrangements are made. **Assignments must be done in a neat, organized manner in order to earn credit.** You will receive a page of assignment expectations prior to turning in your first assignment.
- *Quizzes:* Quizzes will be announced ahead of time. **Missed quizzes cannot be made up** unless missed for a school activity and arrangements are made prior to the absence.
- *Regular Exams:* There will be three exams given during the term. **You MUST take exams at the scheduled times and there will be no make-up for missed exams**. See the schedule at the end of this syllabus for exam dates. Make-up exams can be given for **previously arranged absences** if you have a good reason to miss an exam.
- *Final Exam:* The final will be given during the time period listed in the calendar below. It will be comprehensive and will be worth 150 points. **You MUST take the final at the designated time, so make all travel arrangements accordingly.**

Grades will be computed from the above as follows:

- Each regular exam will be worth 100 points and the final exam will be worth 150 points.
- For each individual, the number of assignment and quiz points possible will be the larger of the number they earned and 70% of what is possible. This means that an individual who earns at least 70% of the assignment points possible will receive 100% for however many points they earn. Those earning less than 70% of the points possible will receive a percentage less than 100%.

The percentage of points possible that are earned will be computed, and a separate percentage will be computed based on exam scores alone. You will receive a letter grade based on the higher of the two percentages, using the grading scale 90-100% $\Rightarrow$A, 80-89% $\Rightarrow$B, 70-79% $\Rightarrow$C, 60-69% $\Rightarrow$D, and below that is an F.

As an example, suppose that your scores on the exams were 83, 75, 88 and 124 points, and suppose also that you earned 150 quiz and assignment points with the total number possible being 193. 70% of 193 is 135, so you earn 43 out of 43 for quizzes and 150 out of 150 for assignments. Thus you will have earned $83 + 75 + 88 + 124 + 150 = 520$ points out of $100 + 100 + 100 + 150 + 150 = 600$ points possible. Your percentage score would then be $520/600 = 87\%$. You would then receive a B in the course.

Suppose that another individual in the same class had exam scores of 75, 58, 71 and 104 points, and that individual earned 84 quiz and assignment points. This individual receives 84 out of 135 for quizzes and assignments. Their total number of points would be $75 + 64 + 71 + 104 + 84 = 398$ out of $100 + 100 + 100 + 150 + 135 = 585$, so their percentage score including assignments and quizzes would be $398/585 = 68\%$. Based on exams alone, their grade is $75 + 64 + 71 + 104 = 314$ out of $100 + 100 + 100 + 150 = 450$, or $314/450 = 70\%$.Their letter grade for the course would then be a C.

Other Things of Importance:

- *Incomplete Grades:* An incomplete grade can only be assigned to you under the following circumstances:

  1. You have/had a grade of 70% or better (including zeros for any work not done) by the date to withdraw with a W.

  2. You have a SERIOUS problem that begins after the withdraw date and prevents you from being able to complete the term.

  An incomplete grade will definitely not be assigned in the event that you are not performing well in the course and fear that you may not obtain a passing grade!

- *Disabilities:* Students with a documented disability who require assistance or academic accommodations should contact the office of Disability Services immediately to discuss eligibility. Disability Services staff are located on both the Klamath Falls and Wilsonville campuses and arrangements can be made to meet with students on any campus. Meetings are by appointment only, so please contact the Disability Services office. Specific information and Disability Services forms can be found at www.oit.edu, then go to "Academics" and click on "Student Success Center" and then "Disability Services." This link leads to the department's website: http://www.oit.edu/academics/ssc/disability-services

Calendar: Below are some important dates for the term.

April 17th - **Class Cancelled**

April 18th - **Exam One**

April 23rd - **Class Cancelled**

May 8th - **Exam Two**

May 18th - Last day to withdraw with a "W"

May 28th - **Memorial Day Holiday - no class**

May 30th - **Exam Three**

Monday, June 11th, 8:00 AM - 10:00 AM - **Final Exam**

Math 254N OBJECTIVES AND PERFORMANCE CRITERIA **Spring 2018**

Course Description: Vectors, vector functions, and curves in two and three dimensions. Surfaces, partial derivatives, gradients, and directional derivatives. Multiple integrals using rectangular and other coordinate systems. Physical and geometric applications.

Course Objectives: After completing this course, students will have a working understanding of

1. vectors in two- and three-space, lines and planes in three-space
2. vector-valued functions of one variable
3. single-valued functions of two and three variables
4. multiple integration

Students will also communicate mathematical ideas and operations using correct and appropriate notation.

Learning Outcomes and Performance Criteria

1. Understand vectors in two- and three-space, lines and planes in three-space, and be able to perform associated computations.
   (a) Draw the scalar multiple of a drawn vector, or the sum or difference of two drawn vectors. Illustrate both the parallelogram method and tip-to-tail method for adding two vectors.
   (b) Find the vector from one point to another.
   (c) Perform algebraic operations with vectors.
   (d) Find the norm of a vector. Find a vector satisfying given direction and magnitude criteria.
   (e) Find the dot product of two vectors, and know that it is a scalar. Determine whether two vectors are orthogonal (perpendicular).
   (f) Find the cross product of two vectors in 3-space. Know that the cross product of two vectors in 3-space is *a vector* that is orthogonal to both original vectors.
   (g) Tell whether a given operation with scalars and/or vectors is defined.
   (h) Find the parametric equations for a line
      i. through a given point and parallel to a given vector,
      ii. through two given points in 2 or 3-space.
   (i) Find the equation of a plane, given
      i. a point on the plane and a normal vector to the plane,
      ii. three points on the plane.
   (j) Draw the projection of one drawn vector on another drawn vector.
   (k) Draw the components of a vector $\mathbf{v}$ that are parallel and perpendicular to a vector $\mathbf{b}$. Find the components algebraically.
   (l) Determine whether two planes are parallel, perpendicular, or neither. Determine whether a line and a plane are parallel, perpendicular, or neither.
   (m) Find the point of intersection of a line and a plane.

2. Understand vector-valued functions of one variable and their derivatives, perform associated computations, and apply understanding and computations to solve problems.

   (a) Find the rectangular equation of the path for parametric motion in two dimensions and identify its "shape" (line, circle, ellipse, etc.).

   (b) Find velocity, speed and acceleration for parametric motion in two or three dimensions.

   (c) Determine when and where a particle reaches maximum or minimum speed, and find that speed.

   (d) Given the path and direction of motion of a particle and information about whether it is speeding up, slowing down, or moving at a constant speed at a point, sketch possible velocity and acceleration vectors at that point. Sketch possible tangential and normal components of the acceleration at that point.

   (e) Given the velocity and normal and tangential components of a particle, determine whether the particle is (a) speeding up, slowing down or moving at constant speed and (b) whether the path of the particle is straight or curved.

   (f) Find displacement and distance travelled for parametric motion in two or three dimensions.

   (g) Solve an initial value problem for parametric motion in two or three dimensions.

   (h) Find the curvature of a path at a given point.

   (i) Find the tangential and normal *vector* components of the acceleration vector; find the tangential and normal *scalar* components of the acceleration vector. Write the acceleration vector at some time in the form $\mathbf{a} = a_T\mathbf{T} + a_N\mathbf{N}$.

   (j) Apply initial value problem methods to solve projectile motion problems.

3. Understand single-valued functions of two or three variables and their derivatives, perform associated computations, and apply understanding and computations to solve problems.

   (a) Match a level curve plot of a function of two variables with its three-dimensional plot. Sketch the trace of a function of two variables in a plane parallel to the xz-plane or yz-plane.

   (b) Determine the average rate of change of a function of two or three variables from one point to another for a function of two variables in tabular, level curve plot, or equation form, or for a function of three variables in equation form.

   (c) Find and interpret (give location, direction, change in dependent variable per unit of change in independent variable) partial derivatives of a function at a point.

   (d) Find vectors and a plane tangent to a surface at a point. Find and use linear approximations of functions of one, two and three variables.

   (e) Find and interpret (location, direction, change in dependent variable per unit of change in independent variables) directional derivatives of a function at a point.

   (f) Determine the direction in which a function has the greatest rate of increase or decrease at a point, and give that rate. Determine the directions from a point in which a function remains constant.

   (g) Find local and/or absolute minima and maxima of a function of one or two variables. (This includes both the function values *and* where they occur.)

   (h) Given a level curve plot of a function of two variables, determine the locations and approximate values of absolute maxima and minima on a closed region.

   (i) Use calculus to find absolute maxima and minima of a function of two variables on a closed region.

4. Understand multiple and iterated integrals, perform associated computations, and apply understanding and computations to solve problems.

   (a) Evaluate a simple double or triple iterated integral "by hand".

   (b) Set up a double integral over a given region.

   (c) Set up a polar double integral over a given region.

   (d) Find the mass of a plate or solid object with variable density. Set up an expression for finding the centroid of an object.

   (e) Give the polar coordinates of a point in two-space. Give the cylindrical or spherical coordinates of a point in three-space.

   (f) Describe a curve in two-space using polar coordinates. Describe a surface in three-space using cylindrical or spherical coordinates.

Math 254N ASSIGNMENT EXPECTATIONS **Spring 2018**

Your work on assignments should be presented with a reasonable amount of care. *If you turn in work that is messy and/or hard to follow, I will not grade that assignment and you will receive no credit for it.*

Basics:

- **Show work!** There is no point in me collecting your work if there is nothing there to look at except for answers. In a few situations there may be no work to be shown - those situations should be clear to you.
- Never put your work and/or answers on any handout I give you containing the assignment, unless it is clear that I have left room for you to do so.
- I don't care what sort of paper you use. I personally use paper that has been used for something else on one side, and I would encourage you to do that as well if you have a source of such paper. This sort of paper can usually be found in recycle bins near printers around campus.
- If you use clean paper, you may put work on both sides. In fact, I would encourage you to.
- You don't need to put a date, the class name or *my* name on your papers. The main thing is to get *your* name on it somewhere. If the assignment has a number, it is helpful if you put that on the paper along with your name.
- Use a pencil or an erasable pen, and **use an eraser when you want to change something!** The one exception is this: If you really botch a problem and want to start over, just put a big, neat X through the work you don't like and start over.

Arranging Work on the Paper:

- Circle the number of each exercise. Leave a little space between problems.
- Solve all equations downward. Expressions can be simplified across or downward.
- Write any given equations, functions or values at the start of your work for any exercise, but you do not need to write the instructions for that exercise.
- Put a box around each of your answers.

Notation:

- When an expression represents an unknown or a desired quantity, that should be made clear by writing the unknown or the quantity followed by an equal sign, then the expression.
- Use equal signs between things that are equal, but not between things that aren't.
- Use the correct case (lower or upper - small letter or capital letter) for any unknowns, and put arrows over the letters for vectors.
- You will encounter more different kinds of objects in this course than you have in past courses. Use correct notation for the type of object you are working with.

Graphs:

- Axes should be drawn as close to straight and perpendicular to each other as possible. You do not need to use a ruler unless you have trouble drawing something close to a straight line.
- The increments between tick marks should be constant.
- *For any graph*, a tick mark or two on each axis should be labeled with its numerical value, and each axis should be labeled with its variable.
- For a graph of "real life" quantities, each axis should be labeled with its variable *in words*, and the units (in words or using a *standard* abbreviation) should be given along with the variable.

Grading:

- Each exercise will be graded based on the validity of the method used and the correctness of the work.
- Each assignment will have two points of credit based on overall neatness/quality of work and correct use of the "language of mathematics;" notation, use of equal signs where appropriate, labeling expressions or numbers, etc.
- If you lose all of the two neatness/quality points on an assignment you will receive a zero for the entire assignment.