Syllabus
Honors Multivariable Calculus
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Course Description
Multivariable calculus is the study of differential, integral, and vector calculus for functions of more than one variable. Multivariable Calculus is used in the physical sciences, economics, engineering, and computer graphics. Upon completion of this full year course, students will be able to extend differentiation and integration to vector-valued functions, apply vector tools to study curvature, study the motion of a particle along a path, extend the concepts and techniques of differential calculus to functions of several variables, compute partial derivatives, evaluate double and triple integrals, explore vector fields, explore integration over curves, paths, and surfaces, and solve applied problems. Multivariable Calculus is a rigorous course that builds on the skills and concepts students learned in AP Calculus BC. It is equivalent to a third semester of college level calculus. Therefore, this course will receive AP weighting when grades are calculated.

Course Outline

Semester I

Unit 1: Vectors and Geometry of Space (assignment)

In this unit, the concepts of vectors and coordinate systems for three-dimensional space are developed. This is the setting for the study of functions of two variables because the graph of such a function is a surface in space. Vectors provide particularly simple descriptions of lines and planes in space as well as velocities and accelerations of objects that move in space. Students will investigate the dot product and cross product of two vectors; define relationship among points, lines, and planes in three dimensions; understand and apply properties of matrices and determinants including Cramer's Rule and Gaussian Elimination.

3-Dimensional Cartesian Space
- Graphs of Surfaces
- Trace Level Curves
- Quadric Surfaces

Vectors and the Geometry of Space
- Vectors and Geometry
- Dot Product
- Cross Product
- Triple Scalar Product
- Projections

Lines and Planes in Space

- Equations of Lines
- Equations of Planes
- Parallel, Intersecting, and Skew Lines
- Distance between Point/Line, Point/Plane, Line/Line

Unit 2: Vector Functions (assignment)

The functions the students studied so far have been around real-valued functions. The focus of this unit shifts to functions whose values are vectors because such functions are needed to describe curves and surfaces in space. This unit will also include vector-valued functions to describe the motion of objects through space. In particular, the use of vector functions will allow for the development of Kepler's laws of planetary motion.

Space Curves

- Parametric equations
- Plane and Space Curves
- Parametric Derivatives
- Arc length
- Curvature
- Polar Coordinates

Unit 3: Derivatives (assignment)

Physical quantities often depend on two or more variables. In this unit, students will extend the basic ideas of differential calculus to such functions. Students will investigate limits, continuity, and differentiation of functions of two independent variables; define and apply the gradient, the divergence, and the curl.

Functions of Several Variables

- Continuity
- Directional Derivatives and Gradients
- Differentials
- Tangent Planes
- Extrema and Optimization
- Lagrange Multipliers

Semester II

Unit 4: Multiple Integration (assignment)

In this unit, the idea of a definite integral is extended to double and triple integrals of function of two or three variables. These concepts of double and triple integrals are then used to compute volumes, surface areas, masses, and centroids of more general regions than we were able to consider in prior units. Students will explore double and triple integrals and integrals of vectors; use various methods of integration; understand and apply the theorems of Green, Stokes, and Gauss.

- Functions of Several Variables
  - Approximation of Volume
  - Iterated and Double Integrals
  - Double Integrals and Polar Coordinates
  - Spherical and Cylindrical Coordinates
  - Triple Integrals

Unit 5: Applications (culminating project shown below with examples)

In this unit, we explore several physics applications starting with single variable calculus and its limitations. Then we address these limitations when extend these ideas to multivariable calculus, specifically multiple integration.

Applications of Double and Triple Integrals
- Center of Mass
- Wind Pressure
- Hydrostatics
- Probability
- Surface Area

Unit 6: Vector Analysis (assignment)

In this section, we explore four methods to expand the fundamental theorem of calculus to multiple dimensions. Green's theorem and the two-dimensional divergence theorem achieve this in two-dimensional space, while Stokes' theorem and the three-dimensional divergence theorem extend the concept into three-dimensional realms.

Vector Calculus
- Vector Fields
- Gradient Fields
- Line Integrals
- Fundamental Theorem of Line Integrals

- Applications of Vector Calculus
  - Parametric Surfaces
  - Surface Integrals
  - Green’s Theorem

- Divergence Theorem
- Stokes' Theorem

Technology Requirement

We will use Desmos 3D online extensively to:

- Model and animate vector and particle behavior in planes and in space
- Model parametric curves in a plane and in space
- Model 3D surfaces in space
- Model solids in space
- Calculate double and triple integrals
- Create vector fields

Textbook:

Larson, Hostetler, Edwards. *Calculus*. 11th Edition.
This textbook will be our primary resource. You will benefit from reading it. It contains a number of interesting explorations that we will conduct with the goal that you discover fundamental calculus concepts. I will also explain topics in a way that students have found helpful over the years. I encourage cooperative learning, and I believe our entire class benefits from us all working together to help one another construct understanding.

Grading Scale:

90 – 100 – A
80 – 89 – B
70 – 79 – C
60 – 69 – D
Below 60 – F

~~Homework~~ Practice Problems

Homework from the textbook or Khan Academy may or may not always be taken for a grade, but is **highly recommended**. Tests and Quizzes will be based upon the problems assigned as homework. Therefore, it is **your responsibility** to study and ask questions upon the **next day's** class meeting. I will **not** keep up with whom and who doesn't do homework. However, I will assign and grade homework worksheet assignments that I distribute. In fact, it is no longer called homework. They are Practice Problems!

Quizzes

Quizzes will be announced and unannounced throughout the year. Quizzes will also be given as take-home and in-class assessments. I might drop the lowest quiz grade each semester. **I expect you to study and know the content.**

Tests
All tests will be announced. You will be allowed to use the calculator on some problems, **but work is required**. Students must know how to solve problems algebraically, numerically, and graphically. Each Semester will have a cumulative final.

Makeup Assessments
In general, students are expected to complete all assessments (i.e., tests, quizzes) on time. I recognize, however, that a variety of extenuating circumstances sometimes interfere with this, and I am committed to being flexible in working with students, within the bounds of fairness to all.

1. Excused Absence on day of assessment: If a student is absent on the day of an assessment, the assessment is to be made up on the day that the student returns to school, as arranged with the instructor.

2. Excused Absence prior to assessment: If a student is absent for one or more days immediately prior to an assessment, s/he *may* be allowed to delay the assessment by the number of excused days, at the discretion of the instructor. All formal assessments will be announced with advance notice of at least three days, and in general, an absence on the review day prior to a test does not exempt a student from his/her responsibility to prepare for the assessment. Any and all arrangements to delay an assessment ***must*** **be made with the instructor before** the class is scheduled to meet that day, preferably before school.

3. Absence during assessment period: If a student is absent from class but present in school on an assessment day (i.e., due to early dismissal for a sporting event or an outside appointment), **the assessment *must* be completed *that* day or the following school day**. It is the student's responsibility to make appropriate arrangements with the instructor. **Failure to complete the assessment will result in academic consequences, and may result in the student scoring a zero on the assessment, at the discretion of the instructor.**

NOTE: All unexcused absences will result in a zero.

Other circumstances: I realize that other extenuating circumstances (i.e., family emergencies, unusually heavy workloads in other classes, etc.) may make it difficult for a student to complete an assessment on the day that it is scheduled. I will attempt to work with students when this occurs, provided that arrangements are made in advance, before school begins that day. Plan ahead! I will be more likely to respond favorably to requests that are made in advance.

Expectations:
- ✓ You are expected to be ON TIME TO CLASS. This means you should be ready to begin class as soon as the bell rings. You must have a written note from a teacher to excuse ANY tardy.
- ✓ There is to be NO FOOD OR DRINK in the room at any time, unless told otherwise by the teacher.

- ✓ Class ends when I dismiss you. You are not to congregate next to the door waiting for the bell to ring.
- ✓ All students will be expected to have all homework completed on time.
- ✓ If you miss class for any reason, you are expected to pick up assignments upon the NEXT DAYS return.
- ✓ YOU are ACCOUNTABLE for your own performance in this class. Take OWNERSHIP.

DO NOT WAIT UNTIL THE MORNING THAT AN ASSIGNMENT IS DUE TO COME IN FOR HELP! DO NOT WAIT to start your homework the morning it is due. Begin working on an assignment the day it is announced so that you can ask questions in class the next day, or see me for help outside of class. I will not take homework questions during class on the day that it is due if you have had more than one day to work on it. By that time, you have had several opportunities to ask questions, and procrastination will not be tolerated. If you have any problems or concerns, TALK TO ME!

Website – mryousefian.weebly.com

Classroom Expectations

Be Respectful

- To each other: by not talking when teacher, guest speaker, or others are talking
- To the school: by treating school materials properly and upholding ***all*** school rules (i.e. proper use of electronics, ETC.)
- By cleaning up after yourselves

Be Responsible:

- Come to class on time and prepared with *all* necessary materials
- Turn in *all* work complete and on time
- Follow the given directions and stay on task
- Do your own work and be a good team member

How to Succeed in this Class:

1. Be seated and ready to go.
2. Take notes.
3. Ask questions.
4. Do your work.
5. Come in for additional help, i.e. tutoring.
6. Take part in class discussions.
7. Study!!!
8. BE RESPECTFUL!!!

If acquiring any of the materials is a problem, please contact me. Thank you for your time. Please feel free to contact me any time. I will be happy to answer any questions or concerns.

We hope that you want to learn as much as you can about calculus. Mathematicians have been responsible for many great developments throughout history. Much of our understanding of the universe is a direct result of the contributions of mathematicians. Who knows, perhaps we'll discover something during our course of studies. Whatever happens, I hope you learn to view math as more than just numbers, variables, processes, and algorithms. I hope you learn to apply your mathematical understanding to help you create a better understanding of the mathematical nature of our lives.

Sincerely,
Mr. Yousefian

Student Signature: _____Date:_____

Parent/Guardian Signature: _____Date:_____

Parent/Guardian Phone Number: _____

Parent/Guardian Email Address: _____