ILLINOIS VALLEY COMMUNITY COLLEGE

COURSE OUTLINE

DIVISION: Natural Sciences and Business

COURSE: MTH 2003 Calculus and Analytical Geometry III

Date: Spring 2022

Credit Hours: 4

Complete all that apply or mark "None" where appropriate:

Prerequisite(s): MTH 2002 with a grade of C or better

Enrollment by assessment or other measure? ☐ Yes ☒ No
If yes, please describe:

Corequisite(s): None

Pre- or Corequiste(s): None

Consent of Instructor: ☒ Yes ☐ No

Delivery Method:

☒ **Lecture**	**4 Contact Hours**	**(1 contact = 1 credit hour)**
☐ **Seminar**	**0 Contact Hours**	**(1 contact = 1 credit hour)**
☐ **Lab**	**0 Contact Hours**	**(2-3 contact = 1 credit hour)**
☐ **Clinical**	**0 Contact Hours**	**(3 contact = 1 credit hour)**
☒ **Online**		
☒ **Blended**		
☒ **Virtual Class Meeting (VCM)**		

Offered: ☒ **Fall** ☒ **Spring** ☒ **Summer**

CATALOG DESCRIPTION and IAI NUMBER (if applicable):
Topics include: three dimensional vectors, parametric equations, analytical geometry, partial differentiation, multiple integrals, and vector analysis. IAI Equivalent: M1900-3; MTH 903.

ACCREDITATION STATEMENTS AND COURSE NOTES:
None

COURSE TOPICS AND CONTENT REQUIREMENTS:

I. Vectors and the Geometry of Space
   A. Vectors in the Plane
   B. Space Coordinates and Vectors in Space
   C. The Dot Product of Two Vectors
   D. The Cross Product of Two Vectors in Space
   E. Lines and Planes in Space
   F. Surfaces in Space
   G. Cylindrical and Spherical Coordinates

II. Vector - Valued Functions
   A. Introduction to vector-valued functions.
   B. Limits and Derivatives of vector-valued functions.
   C. Integration of vector-valued functions.
   D. Unit tangent and normal vectors.
   E. Curvature.
   F. Motion along a curve.

III. Partial Derivatives
   A. Functions of two or more variables.
   B. Limits and continuity.
   C. Partial Derivatives.
   D. Differentiability and chain rules for function of two variables.
   E. Tangent planes; Total differentials for functions of two variables.
   F. Directional derivatives and gradients for functions of two variables.
   G. Differentiability, directional derivatives, and gradients for functions of three variables.
   H. Functions of n variables; More on the Chain Rule.
   I. Maxima and minima of functions of two variables.
   J. Lagrange multipliers.

IV. Multiple Integrals
   A. Double integrals.
   B. Double integrals over nonrectangular regions.
   C. Double integrals in polar coordinates.
   D. Surface area.
   E. Triple integrals.
   F. Centroids, centers of gravity, Theorem of Pappus.
   G. Triple integrals in cylindrical and spherical coordinates.

V. Topics in Vector Calculus
   A. Line integrals.
   B. Line integrals independent of path.
   C. Green's Theorem.
   D. Introduction to surface integrals.

INSTRUCTIONAL METHODS:
Lecture on new material.
Example problems discussed in class with class participation.
Students assigned homework to complete before the next class.
Homework problems discussed in class.

EVALUATION OF STUDENT ACHIEVEMENT:
Unit Tests
Comprehensive final exam
Projects
Quizzes
Homework checks

INSTRUCTIONAL MATERIALS:
Textbooks
Thomas' Calculus, Hass, Pearson

Resources
None

LEARNING OUTCOMES AND GOALS:
Institutional Learning Outcomes
☐ 1) Communication – to communicate effectively;
☒ 2) Inquiry – to apply critical, logical, creative, aesthetic, or quantitative analytical reasoning to formulate a judgement or conclusion;
☐ 3) Social Consciousness – to understand what it means to be a socially conscious person, locally and globally;
☐ 4) Responsibility – to recognize how personal choices affect self and society.

Course Outcomes and Competencies
Outcome 1 - Students will be able to demonstrate proficiency in working with vectors in both two and three surfaces in three-space.
Competency 1.1 - Students will be able to compute different combinations of the sum, difference and scalar multiple vectors.
Competency 1.2 - Students will be able to compute the length or magnitude of a vector or combinations of vectors.
Competency 1.3 - Students will be able to find unit vectors that tangent to and normal to a graph at a given point.
Competency 1.4 - Students will be able to find a unit vector in the same direction as a given vector.
Competency 1.5 - Students will be able to find a vector with a given magnitude in the same direction as another vector.
Competency 1.6 - Students will be able to write a vector in terms of the angle it makes with the positive x-axis.
Competency 1.7 - Students will be able to resolve a vector into its horizontal and vertical components.
Competency 1.8 - Students will be able to solve application problems using vectors.

Competency 1.9 - Students will be able to find the midpoint of a line segment in three-space.
Competency 1.10 - Students will be able to find the standard form for the equation of sphere a given its center and radius
Competency 1.11 - Students will be able to complete the square to write the equation of a sphere in standard form.
Competency 1.12 - Students will be able to find the terminal point of a vector if the vector and its initial point are given
Competency 1.13 - Students will be able to use vectors to determine if three points lie on the same line.
Competency 1.14 - Students will be able to compute the dot product between two vectors.
Competency 1.15 - Students will be able to find the angle between two given vectors.
Competency 1.16 - Students will be able to determine if two vectors are orthogonal, parallel, or neither.
Competency 1.17 - Students will be able to find the magnitude and direction angles of the resultant of two force vectors with initial points at the origin.
Competency 1.18 - Students will be able to find the projection of u onto v and the vector component of u orthogonal t
Competency 1.19 - Students will be able to find two vectors in opposite directions that are orthogonal to the vector v.
Competency 1.20 - Students will be able to find the work done in moving a particle from P to Q if the magnitude and direction of the force are given by v.
Competency 1.21 - Students will be able to find the cross product of two vectors.
Competency 1.22 - Students will be able to find the area of a parallelogram that has two given vectors as adjacent side
Competency 1.23 - Students will be able to find the triple scalar product of three vectors and use this product to find t volume of a parallelepiped.
Competency 1.24 - Students will be able to use the cross product of two vectors to aid in solving application problems
Competency 1.25 - Students will be able to find parametric and symmetric equations of a line.
Competency 1.26 - Students will be able to find the equation of a plane passing through three given points.
Competency 1.27 - Students will be able to find the angle between two planes and find the parametric equations of the line of intersection.
Competency 1.28 - Students will be able to find the distance between a point and a plane. Competency 1.29 - Students will be able to find the distance between two parallel planes.
Competency 1.30 - Students will be able to find the distance between a point and a line.
Competency 1.31 - Students will be able to match the equation of a quadric surface with its graph.
Competency 1.32 - Students will be able to sketch a cylindrical surface or a quadric surface.

Competency 1.33 - Students will be able to find an equation for the surface of revolution generated by revolving a cur the indicated coordinate plane about the given axis.
Competency 1.34 - Students will be able to convert a point from rectangular coordinates to either cylindrical or spherical coordinates.
Competency 1.35 - Students will be able to convert a point from cylindrical coordinates to either rectangular or spherical coordinates.
Competency 1.36 - Students will be able to convert a point from spherical coordinates to either rectangular or cylindrical coordinates.
Competency 1.37 - Students will be able to find an equation in rectangular coordinates for an equation in cylindrical o spherical coordinates.
Competency 1.38 - Students will be able to convert a rectangular equation to a cylindrical or spherical equation.
Competency 1.39 - Students will be able to sketch a solid in either cylindrical or spherical coordinates.

Outcome 2 - Students will be able to demonstrate knowledge of fundamental concepts of Vector-Valued Functions.

Competency 2.1 - Students will be able to find the domain of a vector-valued function.
Competency 2.2 - Students will be able to evaluate a vector function at a specified value.
Competency 2.3 - Students will be able to express parametric equations as a single vector equation.
Competency 2.4 - Students will be able to find the parametric equations that correspond a given vector equation.
Competency 2.5 - Students will be able to describe the graph of a vector equation.
Competency 2.6 - Students will be able to sketch the graph of a vector function, f(t) and show the direction of increasing t.
Competency 2.7 - Students will be able to compute limits of vector functions.
Competency 2.8 - Students will be able to show that a vector function is continuous or discontinuous at a point.
Competency 2.9 - Students will be able to compute the derivative of a vector function.
Competency 2.10 - Students will be able to draw a sketch of the tangent vector, r1 (t). Competency 2.11 - Students will be able to find parametric equations of the line tangent to the graph of r(t) at the point where t=to.
Competency 2.11 - Students will be able to find the vector equation of a tangent line.
Competency 2.12 - Students will be able to integrate vector-valued functions.
Competency 2.13 - Students will be able to calculate the arc length of a curve defined by vector function.
Competency 2.14 - Students will be able to find parametric equations of a curve using arc length, s, as a parameter.
Competency 2.15 - Students will be able to find the unit tangent vector and the unit normal.
Competency 2.16 - Students will be able to compute the curvature of a curve at specified point using several different formulae.

Competency 2.17 - Students will be able to compute the velocity, acceleration, and speed of a particle moving along a curve defined by a vector function.
Competency 2.18 - Students will be able to write the velocity and acceleration vectors in terms of their tangential and normal components.

Outcome 3 - Students will be able to demonstrate knowledge of fundamental concepts of Partial Derivatives.

Competency 3.1 - Students will be able to evaluate functions of two or more variables.
Competency 3.2 - Students will be able to sketch level curves of a function of two variables.
Competency 3.3 - Students will be able to compute limits of functions of two or more variables.
Competency 3.4 - Students will be able to find partial derivatives of a function of two or more variables.
Competency 3.5 - Students will be able to determine the points of continuity of a function.
Competency 3.6 - Students will be able to find differentials.
Competency 3.7 - Students will be able to apply the chain role to a function of two or more variables.
Competency 3.8 - Students will be able to find directional derivatives for a function of two or three variables.
Competency 3.9 - Students will be able to determine the direction in which the directional derivative is a maximum.
Competency 3.10 - Students will be able to find the gradient vector and interpret it.
Competency 3.11 - Students will be able to find and sketch tangent planes to a surface.
Competency 3.12 - Students will be able to find extrema for a function of two or more variables.
Competency 3.13 - Students will be able to use the method of Lagrange multipliers to find extrema for a function of two or more variables.

Outcome 4 - Students will be able to demonstrate knowledge of fundamental concepts of Multiple Integrals.

Competency 4.1 - Students will be able to evaluate iterated integrals.
Competency 4.2 - Students will be able to find double integrals in Cartesian or polar form.
Competency 4.3 - Students will be able to use double integrals in relation to density, mass, center of mass, surface area, volume and area.
Competency 4.4 - Students will be able to find triple integrals in rectangular, cylindrical, and Cartesian form.
Competency 4.5 - Students will be able to use triple integrals in relation to volumes, mass center of mass.

Outcome 5 - Students will be able to demonstrate knowledge of fundamental concepts of Vector Calculus.

Competency 5.1 - Students will be able to evaluate line integrals (2- and 3-dimensional).

Competency 5.2 - Students will be able to determine if a force field is conservative, and if so, find a potential function for it.

Competency 5.3 - Students will be able to under certain conditions, show that the value of a line integral is independent of its path.

Competency 5.4 - Students will be able to find the work done by a conservative force.

Competency 5.5 - Students will be able to use Green's Theorem to evaluate line integrals.

Competency 5.6 - Students will be able to evaluate surface integrals.