COURSE OUTLINE

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Course Title</th>
<th>Credits</th>
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<tbody>
<tr>
<td>MAT251</td>
<td>Calculus III</td>
<td>4</td>
</tr>
</tbody>
</table>

**Hours:**

<table>
<thead>
<tr>
<th>Lecture/Lab/Other</th>
<th>Co- or Pre-requisite</th>
<th>Implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 Lecture</td>
<td>MAT152 with a minimum C grade or better, successful completion of an equivalent course, or approval of the department chair.</td>
<td>Spring 2019</td>
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</tbody>
</table>

**Catalog description (2018-2019 Catalog):**

Calculus III, Multivariable Calculus, applies the techniques and theory of differentiation and integration to vector-valued functions and functions of more than one variable. Topics include vectors, vector-valued functions, quadratic surfaces in three-space, spherical coordinate systems, partial derivatives and multiple integrals, LaGrange multipliers, the theorems of Gauss, Green and Stokes, and line integrals.

**Is the course New, Revised or Modified?** No

**Required texts/other materials**

1. **Text:** Multivariable Calculus, Stewart, Seventh Edition.
   **Publisher:** Brooks/Cole

2. A graphing calculator is required. Recommended models include the TI-83, TI-84, or TI-86. If other software is used for class, the instructor should make that known to students.

**Revision date:** Spring 2019  
**Course coordinator:** Kyle Anderson  609.570.3359  andersok@mcce.edu

**Information resources:**

- The college library has many books and CDs available for reference.
- WebAssign is an online companion to the text offering a lot of practice.
- The Learning Center has tutoring and help available to the students.
Course-specific General Education Knowledge Goals and Core Skills:

**General Education Knowledge Goals:**

- **Goal 1. Communication.** Students will communicate effectively in both speech and writing.
- **Goal 2. Mathematics.** Students will use appropriate mathematical and statistical concepts and operations to interpret data and to solve problems.
- **Goal 4. Technology.** Students will use computer systems or other appropriate forms of technology to achieve educational and personal goals.

**MCCC Core Skills:**

- **Goal A. Written and Oral Communication in English.** Students will communicate effectively in speech and writing, and demonstrate proficiency in reading.
- **Goal B. Critical Thinking and Problem-solving.** Students will use critical thinking and problem solving skills in analyzing information.
- **Goal D. Information Literacy.** Students will recognize when information is needed and have the knowledge and skills to locate, evaluate, and effectively use information for college level work.
- **Goal E. Computer Literacy.** Students will use computers to access, analyze or present information, solve problems, and communicate with others.

In the Course Competencies/Goals list, General Education Knowledge Goals will be denoted GE and MCCC Core Skills will be denoted CS.

**Course Competencies/Goals:**

Upon successful completion of this course, students will be able to demonstrate the ability to:

1. define, calculate, and apply the concepts of vectors, dot and cross products. (CG 1,2,4; CS A,B,E)
2. calculate arc length, unit tangent and normal vectors, curvature, and surface area. (CG 1,2,4; CS A,B,E)
3. use polar, cylindrical, and spherical coordinates. (CG 1,2,4; CS A,B,D,E)
4. describe the basic analytic geometry of lines, planes and spheres in three space, both with vector equations and with scalar equations. (CG 1,2,4; CS A,B,E)
5. analyze and evaluate limits and continuity of multivariable functions. (CG 1,2,4; CS A,B,E)
6. construct representations of functions of two variables as surfaces and level curves. (CG 1,2,4; CS A,B,D,E)
7. perform computations with vector-valued functions. (CG 1,2,4; CS A,B,E)
8. calculate and apply partial derivatives and gradient fields. (CG 1,2,4; CS A,B,E)
9. set up and solve optimization problems for functions of several variables, and find extreme values by a variety of methods, including Lagrange multipliers. (CG 1,2,4; CS A,B,E)
10. apply the properties of curves, surfaces and vector fields to velocity, curl, and divergence problems. (CG 1,2,4; CS A,B, E)
11. calculate double and triple integrals, establish the relationship of the integrals with geometric regions of integration in both rectangular and other coordinate systems, and apply them to area and volume problems. (CG 1,2,4; CS A,B,E)
12. calculate line and surface integrals by applying the fundamental theorems of calculus. (CG 1,2,4; CS A,B,E)
13. determine path independence and state and use Gauss’, Green’s and Stokes’ theorems. (CG 1,2,4; CS A,B,E)
14. apply calculus methods to model and solve applications problems, including selecting or developing appropriate procedures and verifying the validity and appropriateness of the solution. (CG 1,2,4; CS A,B D,E)

In the following Units of Study in Detail Course Competencies/Goals will be denoted CG.

Units of Study in Detail:

UNIT I  Vectors  (3 weeks)

At the conclusion of this unit the student should be able to:

1. define, understand and use vectors in Euclidean 2- and 3-space. (CG 1, 2)
2. compute dot products and cross products, and interpret them as work, area, volume. (CG 1, 14)
3. resolve a vector into its components given a basis of unit orthogonal unit vectors (CG 1,2,14)
4. find the normal vector given the equation of a plane and find the equation of a plane given a normal and a point; similarly in two dimensions for a line. (CG 1, 2, 14)
5. write equations for and identify and sketch quadric surfaces. (CG 1, 4)
6. convert to and from cylindrical and spherical coordinates (CG 1,3)
7. apply cylindrical coordinates to problems involving symmetry around an axis. (CG 1, 3, 14)
8. apply spherical coordinates to problems involving symmetry about a point. (CG 1, 3, 14)

UNIT II  Vector-Valued Functions  (2 weeks)

At the conclusion of this unit the student should be able to:

1. interpret, apply and visualize functions of two (or more) variables. (CG 6, 7)
2. calculate derivatives and integrals of vector-valued functions. (CG 7)
3. parameterize a curve with respect to arc length and find the arc length. (C6G 1, 2, 6, 7)
4. define curvature as a measure of how quickly the curve changes direction. (CG 1, 2, 7)
5. calculate curvature using derivatives and cross products. (CG 1, 2, 7)
6. define, calculate, and use the orthogonal vectors forming the TNB (unit tangent, unit normal, and unit binormal) frame. (CG 1, 2, 7)
7. represent motion as parameterized curves in space and be able to compute velocity and acceleration vectors. (CG 1, 2, 7)
8. demonstrate knowledge of Kepler’s laws of motion and their historical significance to mathematics. (CG 1, 2, 6, 7, 14)

UNIT III Partial Derivatives (4 weeks)

Upon completion of this unit, a student should be able to:

1. define what it means for a function of several variables to be continuous and decide when such functions are continuous. (CG 5,6)
2. define, interpret, and compute partial derivatives (CG 8)
3. approximate a function of two variables by using the tangent plane to create a tangent plane approximation or local linear approximation to the function. (CG 8)
4. establish and use the chain rule for taking the derivative of a multivariable function. (CG 8)
5. compute, interpret, and apply directional derivatives and gradient vectors. (CG 1, 8, 14)
6. compute the gradient and apply it as the direction of greatest increase or as the normal to level curves and surfaces. (CG 1,8,14)
7. apply the second derivative test and extreme value theorem for find maximum and minimum values for functions of two variables. (CG 8, 9, 14)
8. apply the method of Lagrange multipliers to find maximum and minimum values of multivariable functions. (CG 8, 9, 14)

UNIT IV Multiple Integrals (3 weeks)

Upon completion of this unit, a student should be able to:

1. integrate functions of several variables over regions in the plane or in space. (CG 8, 11, 14)
2. use multiple integration to find surface area and volumes. (CG 2, 11, 14)
3. integrate using polar, spherical, or cylindrical coordinates. (CG 3, 11, 14)
4. integrate by change of variables and by using the Jacobian of the transformation. (CG 8, 11, 14)
5. explore physical applications of multiple integrals including computing electric charge, center of mass, moment of inertia, probability, and expected value. (CG 11, 12, 13, 14)

UNIT V Vector Calculus (3 weeks)

Upon completion of this unit, a student should be able to:

1. sketch a vector field given a formula and find a plausible formula given a sketch. (CG 10, 14)
2. recognize the characteristics of a conservative vector field. (CG 10, 14)
3. compute line integrals over a curve. (CG 8, 11, 12, 14)
4. define path independence. (CG 8, 11, 12, 13, 14)
5. demonstrate that line integrals of conservative fields are independent of path.
   (CG 8, 11, 12, 13, 14)
6. state the equivalence of path independent vector fields and gradient vector fields.
   (CG 8, 11, 12, 13, 14)
7. state and apply Green’s Theorem in the plane. (CG 8, 11, 12, 13, 14)
8. define the operations of curl and divergence that can be performed on vector fields.
   (CG 8, 10, 11, 12, 13, 14)
9. calculate, interpret, and apply the curl of a vector field. (CG 8, 10, 11, 12, 13, 14)
10. calculate, interpret, and apply the divergence of a vector field. (CG 8, 10, 11, 12, 13, 14)
11. use the curl and divergence to rewrite Green’s theorem. (CG 8, 10, 11, 12, 13, 14)
12. set up and use surface integrals for various applications. (CG 8, 10, 11, 12, 13, 14)
13. state and apply Stokes’ theorem. (CG 8, 10, 11, 12, 13, 14)
14. interpret, apply, and provide a justification for the divergence theorem, also called
    Gauss’ theorem. (CG 8, 10, 11, 12, 13, 14)

**Evaluation of student learning:**

Tests, quizzes, homework assignments and projects may be used in evaluating the students’
progress throughout the course depending on the individual instructor. It is suggested that four unit
tests and a final exam be used in evaluating the students’ progress. A suggested day-by-day
schedule and suggested homework problems should be available to the students. A final exam must
be given in the course.

A possible plan for determining the students’ final grades is as follows:

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Four Unit Tests</td>
<td>60%</td>
</tr>
<tr>
<td>Cumulative Final Exam</td>
<td>25%</td>
</tr>
<tr>
<td>Homework, Projects and Quizzes</td>
<td>15%</td>
</tr>
</tbody>
</table>

**Statement of Academic Integrity**

Under no circumstance should students knowingly represent the work of another as one’s own.
Students my not use any unauthorized assistance to complete assignments or exams, including but
not limited to cheat-sheets, cell phones, text messaging and copying from another student.
Violations should be reported to the Academic Integrity Committee and will be penalized. Please
refer to the Student Handbook for more details.