Columbus State Community College  
Mathematics Department  
Public Syllabus

Course and Number: MATH 2173 – Engineering Mathematics B 
CREDITS: 5      CLASS HOURS PER WEEK: 5 
PREREQUISITES: A grade of “C” or higher in MATH 1172

DESCRIPTION OF COURSE (AS IT APPEARS IN THE COLLEGE CATALOG):
Multiple integrals, line integrals, vector fields, second order constant coefficient ODEs.

COURSE GOALS:
To develop mathematical thinking and communication skills and to learn to apply precise, logical reasoning in problem solving. To experience geometric as well as algebraic viewpoints and approximate as well as exact solutions. To facilitate the mathematical development of students as they progress from a procedural/computational understanding of mathematics to a broad understanding encompassing logical reasoning, generalization, abstraction, and formal proof and as they become skilled at conveying their mathematical knowledge in a variety of settings, both orally and in writing. To acquaint the students with the basic methods of finding maxima and minima of functions of two variables, multiple integration, vector analysis, and solving elementary second order ordinary differential equations with an emphasis on applications. To further promote and develop students’ abilities to think and reason mathematically and prepare them for further study in engineering.

LEARNING OUTCOMES:

At the end of this course, students will be able to …

• Find the directional derivative of a function of several variables at a point in a given direction.
• Find the gradient of a function.
• Interpret directional derivatives and gradients geometrically.
• Find the relative extrema and saddle points of a function of two variables.
• Find the absolute extrema of a function over a given region.
• Use the Second Partials Test to determine if a critical point is a relative maximum, a relative minimum, or a saddle point, or if the test is inconclusive.
• Solve applications of extrema of functions of two variables.
• Interpret geometrically the rationale of using Lagrange multipliers to optimize a function given a constraint.
• Use Lagrange multipliers to optimize functions of several variables with a given constraint.
• Solve applications involving Lagrange multipliers.
• Evaluate iterated integrals.
• Evaluate double integrals over a rectangular region, and find the volume using a double integral.
• Sketch the solid whose volume is represented by a double integral.
• Choose an appropriate order of integration to evaluate a double integral over a region, and switch the order of integration.
• Use a double integral to find the volume of a given solid.
• Solve applications involving double integrals.
• Evaluate a double integral in polar coordinates.
• Use a double integral in polar coordinates to find the area of a region.
• Convert from rectangular to polar coordinates to evaluate a double integral.
• Use a double integral in polar coordinates to find the volume of a given solid.
• Solve applications involving double integrals in polar coordinates.
• Evaluate triple integrals.
• Sketch the solid whose volume is given by a triple integral, and rewrite the integral in a particular order of integration.
• Use triple integrals to find the volume of a given solid.
• Solve applications involving triple integrals.
• Evaluate triple integrals in both cylindrical and spherical coordinates.
• Find the volume of a solid by a triple integral in cylindrical or spherical coordinates.
• Convert triple integrals from rectangular coordinates to both cylindrical and spherical coordinates, and choose an appropriate one to evaluate.
• Solve applications involving triple integrals in cylindrical and spherical coordinates.
• Find the Jacobian for a given change of variables.
• Sketch the resulting image of a region given a transformation.
• Evaluate double integrals using a given change of variables.
• Use a change of variables to compute the volume of a solid lying above a given region.
• Use representative vectors to sketch a vector field.
• Verify a function is the potential function for a vector field.
• Evaluate a line integral over a given path.
• Evaluate line integrals of vector fields over a given path.
• Compute the work done by a force field on an object moving along a given path.
• Solve applications involving line integrals.
• Identify inverse square vector fields.
• Determine whether a vector field is conservative, and if so, find its potential function.
• Identify when a line integral is independent of path.
• Apply the Fundamental Theorem of Line Integrals to evaluate line integrals.
• Solve applications involving the work done by a force field.
• Use Green’s Theorem to evaluate line integrals.
• Use Green’s Theorem to calculate the work done by a force field.
• Create direction fields for ODEs, and use them to predict behavior of solutions.
• Use Euler’s Method to find approximate solutions to ODEs.
• Construct mathematical models for some real-life systems.
• Write the characteristic equation of a homogeneous linear equation with constant coefficients and use it to find the general solution of the equation for all three cases: distinct roots, repeated roots, and complex roots.
• Explain the general theory behind finding the general solutions to second order homogeneous and non-homogeneous equations.
• Compute the Wronskian and use it to determine if a set of solutions is a fundamental set of solutions to a given homogeneous equation on a given interval.
• Given one solution of a linear second-order differential equation, use reduction of order to find a second solution.
• Verify that a given solution is the general solution to a non-homogeneous ODE.
• Use the method of undetermined coefficients to solve second order non-homogeneous ODEs.
• Use linear second-order differential equations to solve application problems involving spring-mass systems and/or three component series circuits.
GENERAL EDUCATION GOALS:
This course addresses the following Columbus State general education goals:
- Critical Thinking
- Quantitative Literacy

EQUIPMENT AND MATERIAL REQUIRED:
Texas Instruments’ TI-83, TI-83PLUS, TI-84, or TI-84 PLUS Graphing Calculator is highly recommended

TEXTBOOK, MANUALS, REFERENCES, AND OTHER READINGS:

GENERAL INSTRUCTIONAL METHODS:
Lecture, discussion, demonstration, exploration and discovery exercises with the use of visual aids, graphing calculators, and/or computer resources.

ASSESSMENT:
Columbus State Community College is committed to assessment (measurement) of student achievement of academic outcomes. This process addresses the issues of what you need to learn in your program of study and if you are learning what you need to learn. The assessment program at Columbus State has four specific and interrelated purposes: (1) to improve student academic achievements; (2) to improve teaching strategies; (3) to document successes and identify opportunities for program improvement; (4) to provide evidence for institutional effectiveness. In class you are assessed and graded on your achievement of the outcomes for this course. You may also be required to participate in broader assessment activities.

STANDARDS AND METHODS FOR EVALUATION:
The final examination must account for between 25% and 35% (inclusive) of the course grade. The remainder of the course grade is to be determined by the instructor, subject to the following departmental policies:
- NO credit is to be awarded for attendance and/or class participation.
- NO credit is to be awarded for assignments that are only checked for completion rather than graded for correctness.
- Routine homework (e.g. MyMathLab and textbook exercises) should account for no more than 15% of the course grade. Group work and special projects, if utilized, should account for no more than 10% of the course grade. At least 75% of the course grade must be based on proctored, closed book quizzes, tests, and/or final exam. (There may be situations where exceptions to theses caps are appropriate. Please discuss such cases with the Lead Instructor(s) of the course prior to straying from these guidelines.)
- Eliminate extra credit assignments, or limit them to no more than 2% of the course grade.

GRADING SCALE:
Letter grades for the course will be awarded using the following scale:

90-100% - A  
80-89% - B  
70-79% - C  
60-69% - D  
Below 60% - E  

SPECIAL COURSE REQUIREMENTS: None

UNITS OF INSTRUCTION

Unit 1
- Unit of Instruction: Maxima and Minima for Functions of Two Variables
- Student Learning Outcomes: Upon completion of this unit the student will be able to…
  
  • Find the directional derivative of a function of several variables at a point in a given direction (Review).
  • Find the gradient of a function.
  • Interpret directional derivatives and gradients geometrically.
  • Find the relative extrema and saddle points of a function of two variables.
  • Find the absolute extrema of a function over a given region.
  • Use the Second Partial Test to determine if a critical point is a relative maximum, a relative minimum, or a saddle point, or if the test is inconclusive.
  • Solve applications of extrema of functions of two variables.
  • Interpret geometrically the rationale of using Lagrange multipliers to optimize a function given a constraint.
  • Use Lagrange multipliers to optimize functions of several variables with a given constraint.
  • Solve applications involving Lagrange multipliers

- Assigned Reading: Larson/Hostetler: Sections 13.6, 13.8, 13.9 – 13.10
- Assessment Methods: Final exam, tests, quizzes, graded HW, individual or group projects, etc.

Unit 2
- Unit of Instruction: Multiple Integration
- Student Learning Outcomes: Upon completion of this unit the student will be able to…
  
  • Evaluate iterated integrals.
  • Evaluate double integrals over a rectangular region, and find the volume using a double integral.
  • Sketch the solid whose volume is represented by a double integral.
  • Choose an appropriate order of integration to evaluate a double integral over a region, and switch the order of integration.
  • Use a double integral to find the volume of a given solid.
  • Solve applications involving double integrals.
  • Evaluate a double integral in polar coordinates.
  • Use a double integral in polar coordinates to find the area of a region.
  • Convert from rectangular to polar coordinates to evaluate a double integral.
• Use a double integral in polar coordinates to find the volume of a given solid.
• Solve applications involving double integrals in polar coordinates.
• Evaluate triple integrals.
• Sketch the solid whose volume is given by a triple integral, and rewrite the integral in a particular order of integration.
• Use triple integrals to find the volume of a given solid.
• Solve applications involving triple integrals.
• Evaluate triple integrals in both cylindrical and spherical coordinates.
• Find the volume of a solid by a triple integral in cylindrical or spherical coordinates.
• Convert triple integrals from rectangular coordinates to both cylindrical and spherical coordinates, and choose an appropriate one to evaluate.
• Solve applications involving triple integrals in cylindrical and spherical coordinates.
• Find the Jacobian for a given change of variables.
• Sketch the resulting image of a region given a transformation.
• Evaluate double integrals using a given change of variables.
• Use a change of variables to compute the volume of a solid lying above a given region.

- Assigned Reading: Larson/Hostetler: Sections 14.1 – 14.3, 14.6 – 14.8
- Assessment Methods: Final exam, tests, quizzes, graded HW, individual or group projects, etc.

Unit 3
- Unit of Instruction: Vector Analysis
- Student Learning Outcomes: Upon completion of this unit the student will be able to…

  • Use representative vectors to sketch a vector field.
  • Verify a function is the potential function for a vector field.
  • Evaluate a line integral over a given path.
  • Evaluate line integrals of vector fields over a given path.
  • Compute the work done by a force field on an object moving along a given path.
  • Solve applications involving line integrals.
  • Identify inverse square vector fields.
  • Determine whether a vector field is conservative, and if so, find its potential function.
  • Apply the Fundamental Theorem of Line Integrals to evaluate line integrals.
  • Solve applications involving the work done by a force field.
  • Use Green’s Theorem to evaluate line integrals.
  • Use Green’s Theorem to calculate the work done by a force field.

- Assigned Reading: Larson/Hostetler: Sections 15.1 – 15.4
- Assessment Methods: Final exam, tests, quizzes, graded HW, individual or group projects, etc.

Unit 4
- Unit of Instruction: Second Order Linear Equations
- Student Learning Outcomes: Upon completion of this unit the student will be able to…
• Create direction fields for ODEs, and use them to predict behavior of solutions.
• Use Euler’s Method to find approximate solutions to ODEs.
• Construct mathematical models for some real-life systems.
• Write the characteristic equation of a homogeneous linear equation with constant coefficients and use it to find the general solution of the equation for all three cases: distinct roots, repeated roots, and complex roots.
• Explain the general theory behind finding the general solutions to second order homogeneous and non-homogeneous equations.
• Compute the Wronskian and use it to determine if a set of solutions is a fundamental set of solutions to a given homogeneous equation on a given interval.
• Given one solution of a linear second-order differential equation, use reduction of order to find a second solution.
• Verify that a given solution is the general solution to a non-homogeneous ODE.
• Use the method of undetermined coefficients to solve second order non-homogeneous ODEs.
• Use linear second-order differential equations to solve application problems involving spring-mass systems and/or three component series circuits.

- **Assigned Reading:** Larson Hostetler: Section 6.1, Boyce/DiPrima: Sections: 3.1 – 3.5, 3.7 – 3.8
- **Assessment Methods:** Final exam, tests, quizzes, graded HW, individual or group projects, etc.

**ATTENDANCE POLICY:** Determined by instructor
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