Learning Objectives
MATH 220 Matrices

Upon successful completion of MATH 220, the student will be able to:

1. Identify a system of linear equations (or linear system) and describe its solution set
2. Write down the coefficient matrix and augmented matrix of a linear system
3. Use elementary row operations to reduce matrices to echelon forms
4. Make use of echelon forms in finding the solution sets of linear systems
5. Perform standard operations with vectors in Euclidean space
6. Understand the meaning of linear independence/dependence and span
7. Interpret linear systems as vector equations
8. Define matrix-vector product and be able to interpret linear systems as matrix equations
9. Determine the parametric vector form of solutions of linear systems
10. Relate the solution set of a consistent inhomogeneous linear system to the solution set of its associated homogeneous equation
11. Determine whether sets of vectors are linearly independent or dependent
12. Identify a linear transformation between Euclidean spaces
13. Determine the standard matrix of a linear transformation between Euclidean spaces
14. Understand the notion of one-to-one mapping and onto mapping
15. Perform standard operations with matrices including addition, scalar multiplication, and multiplication
16. Compute the inverse of a matrix, if it exists
17. Understand and use the various characterizations of an invertible matrix
18. Determine if a given subset of a Euclidean space is a subspace
19. Describe the column space and nullspace of a matrix and how to determine these spaces
20. Find a basis of a subspace of a Euclidean space
21. Define the concept of dimension and how to use the rank plus nullity theorem
22. Define and compute determinants
23. Make use of the properties of determinants in their calculation
24. Find eigenvalues and eigenvectors of square matrices
25. Diagonalize square matrices
26. Compute the matrix of a linear transformation relative to given bases
27. Compute the inner product of vectors, lengths of vectors, and determine if vectors are orthogonal
28. Recognize an orthogonal set, orthogonal basis and orthogonal matrix
29. Find the orthogonal projection of a vector onto a subspace
30. Find an orthogonal basis using the Gram-Schmidt process
31. Determine the least-squares solutions of linear systems
32. Orthogonally diagonalize symmetric matrices
33. Reduce a quadratic form to principal axes

Learning Objectives
MATH 230 Calculus and Vector Analysis

Upon successful completion of MATH 230, the student will be able to:

1. Perform standard operations on vectors in two-dimensional space and three-dimensional space
2. Compute the dot product of vectors, lengths of vectors, and angles between vectors
3. Compute the cross product of vectors and interpret it geometrically
4. Determine the equations of lines and planes using vectors
5. Identify various quadric surfaces through their equations
6. Sketch various types of surfaces
7. Define vector functions of one real variable and sketch space curves
8. Compute derivatives and integrals of vector functions
9. Find the arc lengths and curvatures of space curves
10. Find the velocity and acceleration of a particle moving along a space curve
11. Define functions of several variables and their limits
12. Calculate the partial derivatives of functions of several variables
13. Apply the chain rule for functions of several variables
14. Calculate the gradients and directional derivatives of functions of several variables
15. Solve problems involving tangent planes and normal lines
16. Determine the extrema of functions of several variables
17. Use the Lagrange multiplier method to find extrema of functions with constraints
18. Define double integrals over rectangles
19. Compute iterated integrals
20. Define and compute double integrals over general regions
21. Compute double integrals in polar coordinates
22. Find moments and centers of mass using double integrals
23. Compute triple integrals in cartesian coordinates, cylindrical coordinates and spherical coordinates
24. Apply triple integrals to find volumes and center of mass
25. Change variables in multiple integrals
26. Define vector fields
27. Calculate line integrals along piecewise smooth paths; interpret such quantities as work done by a force
28. Use the fundamental theorem of line integrals
29. Use Green's theorem to evaluate line integrals along simple closed contours on the plane
30. Compute the curl and the divergence of vector fields
31. Compute the area of parametric surfaces in 3-dimensional space
32. Compute surface integrals
33. Apply Stokes' theorem to compute line integrals along the boundary of a surface
34. Use Stokes' theorem to give a physical interpretation of the curl of a vector field
35. Use the divergence theorem to give a physical interpretation of the divergence of a vector field

Learning Objectives
MATH 231 Calculus of Several Variables

Upon successful completion of MATH 231, the student will be able to:

1. Perform standard operations on vectors in two-dimensional space and three-dimensional space
2. Compute the dot product of vectors, lengths of vectors, and angles between vectors
3. Compute the cross product of vectors and interpret it geometrically
4. Determine the equations of lines and planes using vectors
5. Identify various quadric surfaces through their equations
6. Sketch various types of surfaces
7. Define vector functions of one real variable and sketch space curves
8. Compute derivatives and integrals of vector functions
9. Find the arc lengths and curvatures of space curves
10. Find the velocity and acceleration of a particle moving along a space curve
11. Define functions of several variables and their limits
12. Calculate the partial derivatives of functions of several variables
13. Apply the chain rule for functions of several variables
14. Calculate the gradients and directional derivatives of functions of several variables
15. Solve problems involving tangent planes and normal lines
16. Determine the extrema of functions of several variables
17. Use the Lagrange multiplier method to find extrema of functions with constraints

Learning Objectives
MATH 232 Integral Vector Calculus

Upon successful completion of MATH 232, the student will be able to:

1. Define double integrals over rectangles
2. Compute iterated integrals
3. Define and compute double integrals over general regions
4. Compute double integrals in polar coordinates
5. Find moments and centers of mass using double integrals
6. Compute triple integrals in cartesian coordinates, cylindrical coordinates and spherical coordinates
7. Apply triple integrals to find volumes and center of mass
8. Change variables in multiple integrals
9. Define vector fields
10. Calculate line integrals along piecewise smooth paths; interpret such quantities as work done by a force
11. Use the fundamental theorem of line integrals
12. Use Green's theorem to evaluate line integrals along simple closed contours on the plane
13. Compute the curl and the divergence of vector fields
14. Compute the area of parametric surfaces in 3-dimensional space
15. Compute surface integrals
16. Apply Stokes' theorem to compute line integrals along the boundary of a surface
17. Use Stokes' theorem to give a physical interpretation of the curl of a vector field
18. Use the divergence theorem to give a physical interpretation of the divergence of a vector field

Learning Objectives
MATH 250 Ordinary Differential Equations

Upon successful completion of MATH 250, the student will be able to:

1. Identify an ordinary differential equation and its order
2. Verify whether a given function is a solution of a given ordinary differential equation (as well as verifying initial conditions when applicable)
3. Classify ordinary differential equations into linear and nonlinear equations
4. Solve first order linear differential equations
5. Find solutions of separable differential equations
6. Model radioactive decay, compound interest, and mixing problems using first order equations
7. Model population dynamics using first order autonomous equations
8. Apply first order equations to problems in elementary dynamics
9. Find solutions of exact equations
10. Find the general solution of second order linear homogeneous equations with constant coefficients
11. Understand the notion of linear independence and the notion of a fundamental set of solutions
12. Use the method of reduction of order to find a second linearly independent solution of a second order, linear homogeneous equation when one solution is given
13. Use the method of undetermined coefficients to solve second order, linear homogeneous equations with constant coefficients
14. Use the method of variation of parameters to find particular solutions of second order, linear homogeneous equations
15. Use second order linear equations with constant coefficients to model mechanical vibrations
16. Compute the Laplace transform of a function
17. Use shift theorems to compute the Laplace transform and inverse Laplace transform
18. Use the Laplace transform to compute solutions of second order, linear equations with constant coefficients
19. Use the Laplace transform to compute solutions of equations involving impulse functions
20. Perform standard operations on vectors in R^2 and 2×2 matrices
21. Recognize linearly independent vectors in R^2
22. Find eigenvalues and eigenvectors of 2×2 matrices
23. Use the eigenvalue-eigenvector method to find the general solution of first order linear 2×2 homogeneous systems with constant coefficients
24. Sketch and interpret the phase portraits of first order linear 2×2 homogeneous systems with constant coefficients
25. Use the method of linearized stability to determine the stability of equilibrium solutions of planar autonomous systems
26. Use phase portraits and linearized stability to study simple predator-prey models

Learning Objectives
MATH 251 Ordinary and Partial Differential Equations

Upon successful completion of MATH 251, the student will be able to:

1. Identify an ordinary differential equation and its order
2. Verify whether a given function is a solution of a given ordinary differential equation (as well as verifying initial conditions when applicable)
3. Classify ordinary differential equations into linear and nonlinear equations
4. Solve first order linear differential equations
5. Find solutions of separable differential equations
6. Model radioactive decay, compound interest, and mixing problems using first order equations
7. Model population dynamics using first order autonomous equations
8. Apply first order equations to problems in elementary dynamics
9. Find solutions of exact equations
10. Find the general solution of second order linear homogeneous equations with constant coefficients
11. Understand the notion of linear independence and the notion of a fundamental set of solutions
12. Use the method of reduction of order to find a second linearly independent solution of a second order, linear homogeneous equation when one solution is given
13. Use the method of undetermined coefficients to solve second order, linear homogeneous equations with constant coefficients
14. Use the method of variation of parameters to find particular solutions of second order, linear homogeneous equations
15. Use second order linear equations with constant coefficients to model mechanical vibrations
16. Compute the Laplace transform of a function
17. Use shift theorems to compute the Laplace transform and inverse Laplace transform
18. Use the Laplace transform to compute solutions of second order, linear equations with constant coefficients
19. Use the Laplace transform to compute solutions of equations involving impulse functions
20. Perform standard operations on vectors in R^2 and 2×2 matrices
21. Recognize linearly independent vectors in R^2
22. Find eigenvalues and eigenvectors of 2×2 matrices
23. Use the eigenvalue-eigenvector method to find the general solution of first order linear 2×2 homogeneous systems with constant coefficients
24. Sketch and interpret the phase portraits of first order linear 2×2 homogeneous systems with constant coefficients
25. Use the method of linearized stability to determine the stability of equilibrium solutions of planar autonomous systems
26. Use phase portraits and linearized stability to study simple predator-prey models
27. Use the method of separation of variables to reduce some partial differential equations to ordinary differential equations
28. Solve simple eigenvalue problems of Sturm-Liouville type
29. Find the Fourier series of periodic functions
30. Find the Fourier sine and cosine series for functions defined on an interval

31. Apply the Fourier convergence theorem
32. Find solutions of the heat equation, wave equation, and the Laplace equation subject to boundary conditions