| Mathematics | | *Course to Program Map* | | | |
|---|---|---|---|---|---|
| **Program Outcomes: Upon completion of the program, graduates will be able to…** | **Institutional Skills** | **construct single and multivariable mathematical models for real world problems involving continuous change. (fit model/graph)** | **employ appropriate mathematical techniques and attend to precision for solutions. (do the math) (solve)** | **interpret mathematical derivative and integral solutions both written and orally. (communicate)** | **apply algebraic reasoning and properties for problems involving continuous change. (decision making)** |
| **Courses** | | | | | |
| MATH 109 Trigonometry | **13** | **IA** | **IA** | **IA** | **IA** |
| | | | | | |
| MATH 110 Statistics | **123** | **I** | **IA** | | |
| | | | | | |
| MATH 116 Discrete Math | **13** | **I** | | **IA** | **IA** |
| | | | | | |
| MATH 120 Precalculus | **13** | **IA** | **IA** | | **IA** |
| | | | | | |
| MATH 121 Fundamentals of Calculus | **13** | **IA** | **IA** | **IA** | **IA** |
| | | | | | |
| MATH 122 Calculus and Analytic Geometry I | **134** | **RA** | **RA** | **RA** | **RA** |
| | | | | | |
| MATH 123 Calculus and Analytic Geometry II | **13** | **RA** | **RA** | **RA** | **RA** |
| | | | | | |
| MATH 205 Calculus and Analytic Geometry III | **135** | **RMA** | **RMA** | **RMA** | **RMA** |
| | | | | | |
| MATH 206 Differential Equations | **13** | **RMA** | **RMA** | **RMA** | **RMA** |
| | | | | | |

| Mapping | |
|---|---|
| **I** | **Introduced** |
| **R** | **Reinforced** |
| **M** | **Mastered** |
| **A** | **Assessed/Artifact** |

| Essential Skills | |
|---|---|
| **1** | **written communication** |
| **2** | **oral communication** |
| **3** | **critical thinking** |
| **4** | **cultural diversity** |
| **5** | **social responsibility** |

| Employability Skills | |
|---|---|
| **C** | **communication** |
| **P** | **problem solving** |
| **W** | **work ethic** |

| MATH 109 Trigonometry | Curriculum Map | | | |
|---|---|---|---|---|
| Program Outcomes | construct single and multivariable mathematical models for real world problems involving continuous change. (fit model/graph) | employ appropriate mathematical techniques and attend to precision for solutions. (do the math) (solve) | interpret mathematical derivative and integral solutions both written and orally. (communicate) | apply algebraic reasoning and properties for problems involving continuous change. (decision making) |
| **Course SLO: Students will be able to** | | | | |
| define the trigonometric functions using both a right triangle and the unit circle. | | | | |
| define and interpret radian measurement. Recognize and apply circular functions as real-valued functions. | | | **IA** | |
| solve for unknown sides/angles within right triangles and know trigonometric function values for special angles (multiples of $\pi/6$ and $\pi/4$). | | **IA** | | |
| analyze the graphs of the six basic trigonometric functions and their arithmetic combinations using the concepts of period, phase shift, amplitude, and displacement. | | | | |
| derive/verify trigonometric identities, including but not limited to double angle, half angle, angle sum, and angle difference identities. | | | | **IA** |
| define, graph, and apply inverse trigonometric functions. | | | | |
| solve equations involving trigonometric functions. | | **IA** | | |
| find solutions of oblique triangles using the Law of Cosines or Law of Sines. | | **IA** | | |
| solve applied problems including but not limited to vectors. | **IA** | **IA** | | |

| | | | | |
|---|---|---|---|---|
| derive the trigonometric form of complex numbers and perform calculations with them including products and quotients. | | | | **IA** |
| translate between rectangular and polar coordinates and graph within the polar coordinate system. | | | | |

| MATH 110 Statistics | Curriculum Map | | | |
|---|---|---|---|---|
| Program Outcomes | construct single and multivariable mathematical models for real world problems involving continuous change. (fit model/graph) | employ appropriate mathematical techniques and attend to precision for solutions. (do the math) (solve) | interpret mathematical derivative and integral solutions both written and orally. (communicate) | apply algebraic reasoning and properties for problems involving continuous change. (decision making) |
| **Course SLO: Students will be able to** | | | | |
| create graphical and numerical descriptions of quantitative and qualitative data. | | | | |
| calculate probabilities and percentiles related to a general normal distribution. | | **IA** | | |
| distinguish differences in data analysis and interpretation between observational data and data from designed experiments. | | | | |
| calculate and interpret a confidence interval for a single parameter, using both large and small samples. | | **IA** | | |
| perform and interpret a test of hypotheses for a single parameter, using both large and small samples. | | **IA** | | |
| perform and interpret statistical inference on the difference of two parameters. | | **IA** | | |
| fit and interpret a simple linear regression model, including correlation and scatterplots. | **I** | **IA** | | |

| MATH 116 Discrete Math | Curriculum Map | | | |
|---|---|---|---|---|
| Program Outcomes | construct single and multivariable mathematical models for real world problems involving continuous change. (fit model/graph) | employ appropriate mathematical techniques and attend to precision for solutions. (do the math) (solve) | interpret mathematical derivative and integral solutions both written and orally. (communicate) | apply algebraic reasoning and properties for problems involving continuous change. (decision making) |
| **Course SLO: Students will be able to** | | | | |
| determine recursive and closed formulas for numerical sequences. | | | | |
| apply the operations of propositional logic to determine the equivalence of propositions and the truth of implications. | | | | **IA** |
| apply proof by induction, by contradiction, and the pigeonhole principle. | | | | **IA** |
| apply the language of sets and set properties to number systems. | | | | **IA** |
| determine the properties of a particular relation. | | | | |
| apply permutations, combinations, and the binomial theorem to counting. | **I** | | **IA** | |
| determine probabilities of events using combinatorics. | **I** | | **IA** | |
| categorize systems of vertices and edges using graphs and trees. | | | | |

| MATH 120 Precalculus | Curriculum Map | | | |
|---|---|---|---|---|
| Program Outcomes | construct single and multivariable mathematical models for real world problems involving continuous change. (fit model/graph) | employ appropriate mathematical techniques and attend to precision for solutions. (do the math) (solve) | interpret mathematical derivative and integral solutions both written and orally. (communicate) | apply algebraic reasoning and properties for problems involving continuous change. (decision making) |
| **Course SLO: Students will be able to** | | | | |
| algebraically and graphically analyze functions (including polynomial, radical, absolute value, piecewise-defined, rational, exponential, and logarithmic), determining any intervals where the function is increasing or decreasing, intercepts, asymptotes, symmetry, maxima and minima. | | | | |
| apply transformations, including translations, reflections, stretching, and compressing. | | | | |
| perform binary operations on functions, including addition, subtraction, multiplication, division, and composition. | | | | |
| find the zeros (real and complex) of a polynomial function. | | **IA** | | |
| solve polynomial and rational inequalities. | | **IA** | | |
| determine and analyze the inverse of a function. | | | | |
| simplify expressions using the properties of exponents and logarithms. | | | | |
| solve exponential and logarithmic equations. | | **IA** | | |
| solve application problems involving exponential and logarithmic models. | **IA** | **IA** | | |
| convert angles to degrees or radians | | | | |
| compute arc length, area of a sector, linear and angular velocity. | | | | |

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|---|---|---|---|---|
| determine the values of trigonometric functions and the inverse trigonometric functions. | | **IA** | | |
| graph the sine, cosine, and tangent functions using phase shifts, periodicity, and amplitude. | | | | |
| simplify trigonometric expressions and establish or verify trigonometric identities. | | | | **IA** |
| solve trigonometric equations. | | **IA** | | |
| solve right triangles using right-angle trigonometry. | | **IA** | | |
| solve oblique triangles using the Law of Sines and Law of Cosines. | | **IA** | | |
| solve applications involving triangles. | **IA** | **IA** | | |
| solve nonlinear systems of equations. | | **IA** | | |
| decompose a rational function into partial fractions. | | | | |

| MATH 121 Fundamentals of Calculus | Curriculum Map | | | |
|---|---|---|---|---|
| Program Outcomes | construct single and multivariable mathematical models for real world problems involving continuous change. (fit model/graph) | employ appropriate mathematical techniques and attend to precision for solutions. (do the math) (solve) | interpret mathematical derivative and integral solutions both written and orally. (communicate) | apply algebraic reasoning and properties for problems involving continuous change. (decision making) |
| **Course SLO: Students will be able to** | | | | |
| evaluate limits using the formal limit definition, algebraic methods, and numerical or graphical methods. | | | | **IA** |
| apply the definition of continuity and determine values for removable and non-removable discontinuities. | | | **IA** | |
| find derivatives both explicitly and implicitly of algebraic functions using the limit definition and the power, product, quotient and chain rules. | | **IA** | | **IA** |
| apply derivatives to finding equations of tangent lines, solving applications involving marginal or motion, finding related rates, solving optimization problems, forming the differential of a function, and performing curve analysis. | **IA** | **IA** | **IA** | |
| find indefinite integrals (anti-derivatives) using basic techniques as well as substitution, change of variable, long division, completing the square, integration by parts, and integral tables. | | | | **I** |
| evaluate definite integrals using the Fundamental Theorem of Calculus, calculator techniques and numerical methods. | | | **IA** | |
| differentiate and integrate basic transcendental functions and solve applications involving present value. | **IA** | | **I** | |

| MATH 122 Calculus and Analytic Geometry I | Curriculum Map | | | |
|---|---|---|---|---|
| Program Outcomes | construct single and multivariable mathematical models for real world problems involving continuous change. (fit model/graph) | employ appropriate mathematical techniques and attend to precision for solutions. (do the math) (solve) | interpret mathematical derivative and integral solutions both written and orally. (communicate) | apply algebraic reasoning and properties for problems involving continuous change. (decision making) |
| **Course SLO: Students will be able to** | | | | |
| evaluate the limit of a function at a point both algebraically and graphically. | | **IA** | | |
| evaluate the limit of a function at infinity both algebraically and graphically. | | **IA** | | |
| use the definition of a limit to verify a value for the limit of a function. | | **IA** | | **IA** |
| use the limit to determine the continuity of a function. | | **IA** | | |
| apply the Intermediate-Value Theorem. | | **IA** | | **IR** |
| use the limit to determine differentiability of a function. | | **IA** | | |
| use the limiting process to find the derivative of a | | **RA** | | **IA** |
| find derivatives involving powers, exponents, and sums. | | **RA** | | |
| find derivatives involving products and quotients. | | **RA** | | |
| find derivatives involving the chain rule. | | **RA** | | |
| find derivatives involving exponential, logarithmic, and trigonometric functions. | | **RA** | | |
| find derivatives involving implicit differentiation. | | **RA** | | |
| use the first derivative to find critical points. | | **RA** | | |
| apply the Mean-Value Theorem for derivatives. | | **RA** | | **R** |
| determine the behavior of a function using the first derivative. | | | **IA** | |
| use the second derivative to find inflection points. | | **RA** | | |
| determine the concavity of a function using the second derivative. | | | **IA** | |

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|---|---|---|---|---|
| sketch the graph of the function using information gathered from the first and second derivatives. | | **RA** | **IA** | |
| interpret graphs of functions. | | | **IA** | |
| use the derivative to find velocity, acceleration, and other rates of change. | | **RA** | **IA** | |
| use the derivative to find the equation of a line tangent to a curve at a given point. | | | **IA** | |
| use optimization techniques in areas such as economics, the life sciences, the physical sciences, and geometry. | **IA** | **RA** | **IA** | |
| solve related rates problems. | **IA** | | **IA** | |
| use Newton's Method. | | **RA** | **IA** | |
| use differentials to estimate change. | | | **IA** | |
| find area using Riemann sums and integrals. | | | **IA** | |
| express the limit of a Riemann sum as a definite integral. | | | | **R** |
| evaluate the definite integral using geometry. | | | **IA** | **R** |
| integrate algebraic, exponential, and trigonometric functions. | | | | **R** |
| evaluate definite integrals using the Fundamental Theorem of Calculus. | | | **IA** | |
| apply the Mean-Value Theorem for integrals. | | | | **R** |
| integrate indefinite integrals. | | | | **R** |
| integrate using substitution. | | | | **R** |
| approximate integrals using Simpson's Rule and the Trapezoidal Rule. | | **RA** | | |

| MATH 123 Calculus and Analytic Geometry II | Curriculum Map | | | |
|---|---|---|---|---|
| Program Outcomes | construct single and multivariable mathematical models for real world problems involving continuous change. (fit model/graph) | employ appropriate mathematical techniques and attend to precision for solutions. (do the math) (solve) | interpret mathematical derivative and integral solutions both written and orally. (communicate) | apply algebraic reasoning and properties for problems involving continuous change. (decision making) |
| **Course SLO: Students will be able to** | | | | |
| use integration to find area between curves and arc length of curves. | **RA** | | **RA** | |
| use integration to find volume and surface area of a surface of revolution. | **RA** | | **RA** | |
| use integration to find work and force. | **RA** | | **RA** | |
| use integration to find centroids. | **RA** | | **RA** | |
| apply integration by parts, trigonometric substitution, & partial fractions to solve integrals. | | **RA** | | |
| identify when to use and apply L'Hopital's Rule. | | | | **RA** |
| evaluate improper integrals. | | **RA** | | |
| determine and compute convergence/divergence of sequences and series. | | | **RA** | **RA** |
| find power series and Taylor and Maclaurin series representations of a given function and determine their intervals of convergence. | | | | **RA** |
| identify conic sections and their features. | | | | |
| represent curves by parametric equations, and apply the methods of calculus to them. | | | **RA** | |
| represent curves by polar equations. | | | | **RA** |
| determine the area of a solid formed by a polar function. | **RA** | | | |
| determine the arc length of a curve of a polar function. | **RA** | | | |

| | MATH 205 Calculus and Analytic Geometry III | Curriculum Map | | | |
|---|---|---|---|---|---|
| | Program Outcomes | construct single and multivariable mathematical models for real world problems involving continuous change. (fit model/graph) | employ appropriate mathematical techniques and attend to precision for solutions. (do the math) (solve) | interpret mathematical derivative and integral solutions both written and orally. (communicate) | apply algebraic reasoning and properties for problems involving continuous change. (decision making) |
| | **Course SLO: Students will be able to** | | | | |
| **VECTORS** | definitions and properties associated with vectors (both 2 and 3 dimensional) and be able to perform all standard vector computations. | | | **R** | |
| | write the equation of a sphere, a line (in 3-space) and a plane given relevant data about the structure. | | **RA** | | |
| | determine the angle between two lines or two planes. | | **RA** | | |
| | determine the distance between a point and a plane or between two planes. | **RA** | **RA** | | |
| **SURFACES IN SPACE** | forms of equations in 3-space for a cylinder, cone, ellipsoid, paraboloid, hyperboloid of one sheet and hyperboloid of two sheets. | **RA** | | | |
| | graph these equations as well as work applications involving these structures. | **RA** | **RMA** | **R** | |
| | convert between Cartesian, cylindrical and spherical coordinates. | | **RA** | | **RMA** |
| | graph surfaces given in cylindrical or spherical coordinates. | | **RA** | **R** | |
| | convert functions between Cartesian, cylindrical and spherical coordinate form. | | **RA** | | **RMA** |
| | find limits, derivatives and integrals of vector-valued functions. | | **RA** | | |

| | | | | | |
|---|---|---|---|---|---|
| VECTOR-VALUED FUNCTIONS | understand the relationships concerning the position function, the velocity function and the acceleration function in space. | | | RMA | |
| | work applications involving projectile motion. | RA | RMA | | |
| | find directed distance along a curve and the unit tangent vector of a differentiable curve. | RA | RA | | |
| | find curvature, the radius of curvature and the Principal Unit Normal Vector of a plane curve. | | RA | | |
| | find the tangential and normal scalar components of acceleration. | | RA | | |
| FUNCTIONS OF TWO OR MORE VARIABLES | determine the domain of a function in three variables. | | RA | R | |
| | bounded/unbound region, open/closed point and interior point. | | | | |
| | find and sketch c-level curves of a two-variable function. | | RA | | |
| | graph surfaces by hand and also using a 3-D computer grapher. | | RA | R | |
| | find limits and analyze continuity on a surface generated by a two-variable function. | | RA | | |
| | determine partial derivative (both first order and higher orders) for functions of two or more variables. | | RA | | |
| | determine the differentiability and continuity of a function in two variables. | | RA | | |
| | write a linear approximation of a function in two variables at a given point. | | RA | | |
| | find the total differential of a function in two variables. | | RA | | |
| | write and use chain rules for functions in two or more variables. | | RA | | |
| | determine directional derivatives, gradient vectors and tangent planes. | | RA | | |
| | the student should be able to find extrema and saddle points of functions in two variables. | | RMA | | R |
| | use Lagrange multipliers to find constrained extrema of functions in two variables. | RA | RMA | | |

| | | | | | |
|---|---|---|---|---|---|
| MULTIPLE INTEGRALS | evaluate double and triple integrals. | | RA | | |
| | use the double integral to find the area of a region. | RMA | RMA | | |
| | use the double integral to find the moments and the centroid of a region. | RMA | RMA | | |
| | use double integrals to find the average value of a function on a region. | RA | RA | | |
| | work a double integral either in rectangular or polar coordinate form. | | RA | | |
| | use the triple integral to find the volume of a solid or the area of a region. | RMA | RMA | | |
| | use the triple integral to find the average value of a function in space. | RA | RA | | |
| | use the triple integral to find the mass, moments and centroid of a solid. | RMA | RMA | | |
| | work triple integrals in either rectangular, cylindrical or spherical coordinates. | | RA | | |
| | change variables in a double or triple integral using the Jacobian. | | RA | | R |
| INTEGRATION IN VECTOR FIELDS | technique for evaluating a line integral. | | | | |
| | line integral to find the mass, moments and centroid of a thin rod or wire. | RA | RA | | |
| | line integral to find the work done by a force in a vector field; also to find flow along a curve and flux across a curve. | RMA | RA | | |
| | divergence and curl of a vector function. | | RA | | |
| | green's Theorem to convert a line integral to a double integral (and visa versa). | | RA | | R |
| | find surface integrals and flux across a surface. | | RA | | |
| | surface integral to find the mass, moments and centroid of thin shells. | RA | R | | |
| | divergence theorem to evaluate surface integrals. | | R | | |
| | stake's Theorem to convert a surface integral to a line integral (or visa versa). | | R | | |
| | fundamental theorem of line integrals in order to evaluate line integrals which are independent of path. | | RA | | R |

| | | | | | |
|---|---|---|---|---|---|
| | conservative field, potential function and exact differential form and their connections to each other. | | **RA** | | **R** |

| MATH 206 Differential Equations | Curriculum Map | | | |
|---|---|---|---|---|
| Program Outcomes | construct single and multivariable mathematical models for real world problems involving continuous change. (fit model/graph) | employ appropriate mathematical techniques and attend to precision for solutions. (do the math) (solve) | interpret mathematical derivative and integral solutions both written and orally. (communicate) | apply algebraic reasoning and properties for problems involving continuous change. (decision making) |
| **Course SLO: Students will be able to** | | | | |
| explain the Basic Terminology and Definitions for the Study of Differential Equations. | | | **R** | |
| show proficiency with First-Order Differential Equations. | | **RMA** | | **RMA** |
| show proficiency in Modeling First-Order Differential Equations. | **RMA** | | **RMA** | |
| show proficiency with Higher Order Differential Equations. | | **RMA** | | **RMA** |
| show proficiency in Modeling Higher Order Differential Equations. | **RMA** | | **RMA** | |
| show proficiency with Series Solutions of Linear Equations. | | **RMA** | | **RMA** |
| show proficiency in Laplace Transform. | | **RMA** | | **RMA** |
| show proficiency in the System of Linear First-Order Differential Equations. | | **RMA** | | **RMA** |
| show proficiency in Numerical Solutions of Ordinary Differential Equations. (if time permits). | | **RMA** | | |