Miami-Dade Community College
PHZ 3113 B Mathematical Physics

PHZ 3113 - 3 credits

Course Description

This course will reinforce the background gained in the previous math courses. It will also supplement those topics with new theory and applications, while providing some powerful math tools to be used in the 3000-4000 level physics courses. Emphasis will be placed on applications, problem-solving and computer simulations.

Pre-requisites: MAC2311, MAC2312, MAP2302, PHY2049

Course Competencies

Competency 1- The student will demonstrate knowledge, comprehension, analysis and application of vector calculus by:

a) Defining and performing operations on scalars, vectors and tensors in different coordinate systems.
b) Defining and performing differential vector calculus operations on vector and scalar fields.
c) Defining and performing integral vector calculus operations on vector fields.
d) Deriving and applying theorems relating vector calculus operations, such as Stokes' theorem and the divergence theorem.

Competency 2- The student will demonstrate knowledge, comprehension, analysis and application of elementary linear algebra, by:

a) Stating and applying the properties of vector spaces and matrices.
b) Relating and applying matrices to the solution of linear equations.
c) Using basis vectors in the context of the dimensionality of vector spaces and linear independence.
d) Performing similarity transformations and matrix diagonalization.

Competency 3- The student will demonstrate knowledge, comprehension, analysis and application of complex variables, by:

a) Defining and performing calculations using complex numbers and the complex plane.
b) Mapping multivalued functions in the complex plane.
c) Defining and performing differentiations and integrations in the complex plane.
d) Deriving and applying complex variable theorems involving analyticity and residues
e) Defining and applying Taylor and Laurent expansions in the complex plane.
f) Describing electromagnetic waves and alternating circuits using complex variables.

Competency 4- The student will demonstrate knowledge, comprehension, analysis and application of differential equations, by:

a) Stating general properties of differential equations.
b) Solving analytically linear, ordinary differential equations.
c) Applying differential equations to situations involving using Newton's Second Law, simple harmonic motion, electric circuits, etc.
d) Using power series to solve differential equations.
e) Describing different numerical methods used to solve differential equation.
f) Using Runge-Kutta methods to solve first-order and higher order differential equations
g) Implementating Runge-Kutta methods using spreadsheets and other computer software.
h) Applying numerical methods to situations which involve orbits, oscillations, etc.
i) Solving partial differential equations using separation of variables and applying them to situations involving boundary conditions.

Competency 5- The student will demonstrate knowledge, comprehension, analysis and application of Fourier series, by:

a) Stating Fourier's theorem.
b) Expanding functions as Fourier series.
c) Using Fourier series to solve differential equations.
d) Analyzing the convergence of Fourier series.

Competency 6- The student will demonstrate knowledge, comprehension, analysis and application of the Fourier and Laplace transforms by:

a) Defining and stating the basic properties of these transforms.
b) Using these transforms in the solution of differential equations.
c) Applying Laplace transforms in the solution of electric circuits.
d) Applying the Fourier transforms to the propagation of pulses in dispersive media.

Competency 7- The student will demonstrate knowledge, comprehension, analysis and application of generalized functions by:

a) Defining and stating the basic properties of the delta function.
b) Relating the delta function to delta sequences and other generalized functions or distributions.
c) Representing the delta function as an integral.
d) Performing calculus operations on the delta function.
e) Describing physical quantities using delta functions, such as point charges, line densities, shells, etc.

Competency 8- The student will demonstrate knowledge, comprehension, analysis and application of the Sturm-Liouville theory by:

a) Defining the Sturm-Liouville problem.
b) Deriving the properties of the associated eigen functions and eigen values including orthogonality and degeneracy.

c) Using Sturm-Liouville theory to solve problems with rectangular, spherical and cylindrical symmetry.
d) Defining and using special functions such as spherical harmonics, Bessel functions, Legendre functions, etc.
e) Defining and using orthogonal polynomials such as Legendre, Hermite, Laguerre, etc.