COURSE NAME: Numerical Methods
COURSE CODE: MATH3424
LEVEL: III
SEMESTER: II
NUMBER OF CREDITS: 3
PREREQUISITES: Elements of Mathematical Analysis (MATH2401)

RATIONALE:
The science of computing a quantity (or vector, or functional value) is quite separate from the mathematical analysis establishing its existence, uniqueness, or other properties. This course focuses on the mathematical techniques needed to compute commonly sought quantities with a modern computer using floating point arithmetic. It also considers the limitations inherent in such an approach.

COURSE DESCRIPTION:
This is a third-year course for all students of mathematics or related disciplines. The focus is on the mathematical techniques needed to compute solutions of equations, functional values, and other quantities to within a prescribed tolerance. The relevant error analysis and inherent limitation of these methods are also considered.

LEARNING OUTCOMES:
At the end of the course, students will be able to:

1. Solve a nonlinear equation numerically to within a prescribed error tolerance;
2. evaluate the order of convergence of a numerical algorithm;
3. Interpolate a function at a given set of points using Lagrange polynomials or a divided-differences table;
4. Bound the error of interpolation in a given context;
5. Integrate a given function on a finite interval numerically;
6. Bound the error of approximation for an integral computed numerically;
7. Solve systems of linear equations using a standard numerical technique;

8. Bound the error of approximation for the solution to a system of equations computed numerically.

CONTENT:

1. **Numerical Linear Algebra**: Matrices, vectors, and scalars; triangular systems; operation counts; the Cholesky decomposition; Gaussian elimination with partial pivoting; Diagonally dominant matrices; the Jacobi method; the Gauss-Seidel method.
2. **Nonlinear Equations**: *The bisection method; error of approximation with the bisection method; Newton's method; the order of convergence of an algorithm; special computations (such as square roots and reciprocals).*
3. **Polynomial Interpolation**: *Lagrange polynomials; the existence and uniqueness of an interpolating polynomial; the Newton form of the interpolant; the divided differences table; evaluating the interpolating polynomial; errors of approximation*.
4. **Numerical Integration**: *The trapezoid rule; Simpsons rule; the composite Trapezoid and Simpson's rules; errors of approximation; Gaussian quadrature.*
5. Practical implementation in the computer laboratory.

TEACHING METHODOLOGY:

This course will be delivered by a combination of lectures and tutorials. The total of 39 contact hours is broken down as follows: 26 hours of lectures, 7 hours of tutorials and 12 laboratory hours (counted as 6 credit hours). The tutorial will be interspersed with the lectures by having students discuss exercises, revise material as needed, and cover new content each day. Course materials such as exercises, assignments, solutions, etc., will be posted on the webpage http://ourvle.mona.uwi.edu/

ASSESSMENT:

The assessment has three components:

i. Two lab assignments worth 10% each (20% total)
ii. One in-course test (1 hour) worth 20%
iii. One final examination worth 60%

The final examination will be two hours in length and consists of four compulsory questions.

REFERENCE MATERIAL:

Books:

Prescribed:

1. Brian Bradie: A Friendly Introduction to Numerical Analysis, Pearson Education International, 2006 IBSN 0130130540

Highly Recommended:

2. Richard L. Burden and J. Douglas Faires: Numerical Analysis, Thompson Brooks-Cole, 8th Edition, 2005

Recommended:

3. G. W. Stewart: Afternotes on Numerical Analysis, SIAM, 1996

Online Resources:

http://mathworld.wolfram.com/topics/NumericalMethods.html Mathworld is a free online resource for mathematical topics developed by Wolfram, and deriving its functionality from the Mathematica software package. The Numerical Methods category provides interactive demonstrations of many topics covered on this course, including the iterative solution of linear systems, interpolation, and numerical integration.