Course Name:	NUMERICAL METHODS FOR DIFFERENTIAL EQUATIONS
Course Code:	MATH 6623
# of Contact hrs:	One semester (13 weeks - 36 hours of lectures, 10 hours of tutorials and 14 laboratory hours)
Credits:	4
Level:	Graduate
Pre-requisites:	None, Prior knowledge of Computer Programming would be an asset.

RATIONALE:

Differential equations are abundant in the theoretical modelling of problems in science and engineering as well as economics, social science, biology, business, health care, etc. Though there are many well-developed analytical solution techniques available since hundreds of years yet often the systems described by differential equations are so complex, or the systems that they describe are so large that a purely analytical solution is not tractable. It is in these complex systems numerical methods are powerful to obtain an approximate solution of the differential equation. With the advent of high speed computers and advancement in Numerical analysis and efficient computer programmes, one can take up challenging problems in the above fields.

AIM:

This course is intended to introduce and give an understanding of numerical methods for the solution of ordinary and partial differential equations. The methods will be derived and the convergence and stability of the methods will be analyzed. The applications of these methods in solving real world problems will be emphasized. Students will be exposed to modern mathematical software for the practical use of the problems and for better visualization of the convergence and stability of these methods.

LEARNING OUTCOMES:

On completion of this course, the student should be able to:

- Develop a logical mathematical approach to solve differential equations and solve these equations using numerical methods where those are required.
- Investigate the occurrence of errors in different techniques developed in the course.

- Analyze the convergence and stability of the methods of the study.
- Write codes in available software to simulate numerical methods for the differential equations and Understand visually basic computational aspects related to accuracy, stability and convergence of numerical methods.

TEACHING METHODS:

This course will be delivered by a combination of informative lectures, participative tutorials and practical laboratory hours. The total estimated 48 contact hours may be accounted for as follows: 36 hours of lectures, 10 hours of tutorials and 14 laboratory hours (counted as 7 credit hours). Students will be exposed to different numerical methods and the convergence and stability of the methods for solving both ordinary and partial differential equations will be through informative lectures. The tutorials will be interspersed with the lectures by having students discuss exercises and revise material as needed. Modern Mathematical software package will be used in the laboratory for the practicing the models. Course materials such as exercises, lab assignments, solutions, etc., will be posted on the webpage http://ourvle.mona.uwi.edu/

SYLLABUS:

Introduction [9 hrs i.e. 8 hrs lecture + 2 hrs tutorials]

Initial Value Problem (IVP); Boundary Value Problem (BVP); Classification of second order Partial Differential Equations (PDE); Errors in Numerical Methods; Convergence and stability of numerical methods; Fundamentals in Programming, Review of Iterative Solution of Linear Algebraic Systems.

Initial Value Problems for Ordinary Differential Equations [7 hrs i.e. 6 hrs lecture +2 hrs tutorials]

Picards method, Taylor series method, Euler Method; Runge - Kutta methods; Errors and Stability, Predictor corrector methods.

Boundary value problems for Ordinary differential Equations [9 hrs i.e. 8 hrs lecture + 2 hrs tutorials]

Finite Difference Methods; Shooting Method; Collocation methods.

Numerical Solutions to Partial Differential Equations [16 hrs i.e.14 hrs lecture + 4 hrs tutorials]

Finite difference Schemes for Parabolic, Elliptic and Hyperbolic Equations; Consistency, convergence and stability of finite difference schemes; Examples.

Lab hours (14): Implementation of the methods used for the solution of differential equations; practical understanding of convergence and stability.

Total contact hrs = 48 i.e. 36 hrs lecture + 10 hrs tutorials + 14 hrs lab

ASSESSMENT:

The course assessment will be broken into two components; a coursework component worth 50% and a final exam worth 50%.

Two written assignments (5% each);

One in-course test – 20% of overall grade;

One Laboratory test – 20% of overall grade

Final Exams (3 hrs) – 50% of overall grade

REFERENCE MATERIAL

Books:

Iserles, A. (2008). *A First Course in the Numerical Analysis of Differential Equations*, Cambridge University Press, Second Edition. ISBN: 978-0521734905.

LeVeque, R. J. (2007). *Finite Difference Methods for Ordinary and Partial Differential Equations, Steady State and Time Dependent Problems*, SIAM. ISBN: 978-0898716290

Morton W. K. & D. F. Mayers (2005). *Numerical Solution of Partial Differential Equations*, Cambridge University Press, 2nd edition. ISBN: 978-0521607933

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.