COURSE NAME: Partial Differential Equations

COURSE CODE: MATH3421

LEVEL: III

NUMBER OF CREDITS: 3

SEMESTER: 1

PREREQUISITES: MATH2420

RATIONALE:

Partial Differential Equations are at the heart of applied mathematics and many other scientific disciplines such as Physics, Engineering, Chemistry, and Biology. For instance, the heat equation finds application in the conduction of heat in solids, in the diffusion of concentration of liquid or gaseous substance in physical chemistry, in the diffusion of neutrons in atomic piles, in the telegraphic transmission in cables of low inductance and capacitance, in the evolution of probability distributions in random processes. Moreover, the Laplace's equation arises in problems related to gravitational fields, inviscid fluid flows, whereas the wave equation appears in applications such as linearized supersonic airflow, sound waves in a tube, oscillations of a rod, and long water waves in a straight canal. This is just a small sample of the reach variety of applications we can encounter when dealing with the study of partial differential equations.

COURSE DESCRIPTION:

This course analyzes initial and boundary value problems for partial differential equations. Students will be exposed to modern mathematical software specifically designed for the solution of partial differential equations, and will be taught to use this software to explore the properties of the equations encountered on the course.

LEARNING OUTCOMES:

By the end of the Course, students will be able to:

- Classify partial differential equations, and solve first order PDEs using the Method of Characteristics;
- Determine the well-posedness of PDEs with initial/boundary data;
- Solve linear second order PDE using separation of variables and Fourier series for boundary value problems;
- Describe basic physical systems in terms of PDEs using modeling, analytical and software methods;

CONTENT:

Introduction:

Basic concepts and definitions, Strategies for studying PDEs: Well-posed problems, classical solutions, initial and boundary value problems; Typical difficulties;

First order PDEs:

Linear and quasi-linear PDEs, Method of characteristics, Nonlinear first-order PDE: Complete Integrals, envelopes, Characteristics, Charpit's and Jacobi's methods, Introduction to conservation laws;

Second order linear PDEs

Classification in the case of constant coefficients, Classification of general second order operators, Linearity and Superposition. D'Alembert solution of the Wave Equation, Propagation of discontinuities;

Fundamental properties of elliptic and parabolic equations: [

Laplace's equation, Green's theorem and uniqueness for the Laplace's equation, The maximum principle, The heat equation

Separation of variables and Fourier series:

The method of separation of variables, Orthogonality, Completeness and the Parseval's equation, The Riemann-Lebesgue lemma, Convergence of the trigonometric Fourier series, Uniform convergence, Schwarz's inequality and completeness, The heat equation revisited, Laplace's equation in a rectangle and in a circle, wave equation.

Sturm-Liouville theory:

Sturm- Liouville boundary value problems, Eigenvalues and Eigenvectors;

Lab:

Solution of partial differential equations with the help of mathematical software package Maple or Matlab

TEACHING METHODOLOGY

This course will be delivered by a combination of informative lectures, participative tutorials and practical laboratories. The total estimated 39 contact hours are broken down as follows: 27 hours of lectures, 9 hours of tutorials and 6 hours of lab (counts as 3 contact hours). The course material will be posted on the webpage http://ourvle.mona.uwi.edu/. Practice problems and assignments will also be available to

students via this webpage, as well as the solutions to the assignment questions after the due date.

ASSESSMENT

The course assessment will be broken into two components; a coursework component worth 40% and a final examination worth 60% with two hours in length.

The Coursework element will consist of two distinctive parts.

- one course work examination will be worth of 20% of the student's final grade.
- four assignments accounts for 20% (each 5%) of the student's final grade.

REFERENCE MATERIAL:

Books:

1. JOST, J.: Partial Differential Equations, Springer, New York 2002 (Prescribed) ISBN, 0387215956

2. H. F. Weinberger: A first course in partial differential equations, Dover Publications, 1965 (Highly Recommended) ISBN 0536006237

3. L. C. Evans: Partial differential equations, Graduate Studies in Mathematics, American Mathematical Society; 2 edition, 2010 (Recommended) ISBN 9780821849743

Online Resources:

http://ocv.mit.edu/OcwWeb/Mathematics/18-152Fall-2004/CourseHome/index.htm