**University of Management and Technology**

**School of Science**

***Department of Mathematics***

**Course Code:** MTH-703

**Course Title: Topics in Differential Equations-I**

**Program: PhD (MA)**

**Course Outline (Fall Semester 2015)**

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| **Course Coordinator** |  Dr. Muhammad Aziz-ur-Rehman | **Contact** | Ext 3605Cell: 0333-4481003 |
| **Course****Description** | This course is designed of graduate level students in numerical analysis and scientific computing. The majority of the class concerns a mathematical approach to the theory and practice of numerically solving DE’s which frequently arise from different fields of science and engineering. Major thrust of the course will be on implementation of the algorithm designed for numerical solution of models involving ODE, s and PDE,s. |
| **Outlines** | * **An** **Initial value Problem of ordinary Differential Equations:**Basic theory one-step methods(Euler, Runge-Kutta, dericative, error analysis and control). Multi-step method (Adam-Bashforth, Adam-Moulton, Derivation, error analysis (truncation, convergence, root condition, stability)). Aalgorithms and programming of the above methods.
* **Finite Difference Methods:**

Finite Difference approximations. Two point boundary value problems for Odes. Advection equations and the methods of lines. The heat equation and semi-implicit method. Linear convergence/stability analysis. Aalgorithms and programming of the above methods.* **Method for solution of Nonlinear System of Equations:**Newton method for system of nonlinear equations, Steepest Descent technique, Boyden’s method, Numerical method foe finding Eigen values.
* Finite difference approximations to derivatives. Classification of second-order quasi linear partial differential equation.
* **Analysis of Partial Differential Equation**

Explicit and implicit methods for partial differential equation. The local truncation error for different methods. Consistency, stability and convergence of numerical methods. Reduction to a system of ordinary differential equation. The Pade’ approximations to exp(x). Standard finite difference equations via the Pade’ approximants. Ao-stability, Lo-stability and the symbol of the method. The local truncation errors associated with the Pade’ approximants.* **Analysis of Hyperbolic Differential Equation**

First-order hyperbolic equations. Finite-difference methods on a rectangular mesh for first order equations. Propagation of discontinuities. Reduction of first-order equation to a system of ordinary differential equations. The Pade’ difference approximations. Second-order quasi-linear hyperbolic equations. Method of characteristics. Propagation of discontinuities. Finite-order difference methods on a rectangular mesh.* Five to six research papers will be discussed in detail.
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| **Text** **Book(s)** | This course is research based. Latest published literature will be followed. |
| **Reference books/ research Papers:** | * Finite difference Methods by **G D Smith.**
* *“The Numerical Solutions of Ordinary and Partial Differential Equations:”,* 2nd Edition. A Wiley-Intersciences Series of Texts. By **G. Sewell,**
* “Numerical Solutions of Ordinary Differential Equations” Wiley-VCH Verlag.
* Burden and Faires, “Numerical Analysis”. By **D. Greenspan**
* *“Differential Equations and Boundary Value Problems”. By* **W. E. Boyce and R. C. Diorama**
* Computational Methods For Partial differential Equations, by **E. H. Twizell.**
* The finite difference methods in Partial Differential equation, by **A. R. Mittchell** and **D. F. Griffith.**
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| **Assignments** | 6 Assignments | **Project/Presentation** | 1 project from advanced topics and/Presentation from research paper |
| **Mid Term****Examination** | 1 Midterm Exam  | **Final** **Examination** | 1 Final Examination |
| **Attendance** **Policy** | SA would be reported if 20% classes are missed without any accidental or medical or any extreme family matters. |
|  | **Grading Policy** |
| **Assignments**  |  15% | **Project/Presentation** | 15% |
| **Mid Term****Examination** | 30% | **Final** **Examination** | 40% |