# Department of Mathematics
# Faculty of Mathematics & Computer Science
# PhD, Mathematics

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| **Course Code** | AM 607 |
| **Course Title** | Soft Computing Techniques for Differential Equations |
| **Course Credits** | 04 |

**Course objectives:**

The course is primarily designed for the research scholars opting differential equations for advanced study. The computational advancement made it easier to tackle complex mathematical model by the techniques recently developed in the area of differential equations and soft computing.

**Minimum Pre-requisites:**

Differential equations

**Course structure:**

Fuzzy transform: Fuzzy transform and fuzzy partition, Base function, Fuzzy components and inverse fuzzy transform interpolation. Fuzzy transform method for initial value problems, Fuzzy transform method for Boundary value problems, High-order fuzzy component method, Symbolic computation of differential equation with discontinuous coefficients. Implementation of soft computing techniques using Python.

Radial Basis function network: Introduction to Radial basis functions (RBFs): Thin plate spline, Piecewise smooth RBFs, Infinitely smooth RBFs, Gaussian (GA), Multiquadric, Inverse multiquadric, Inverse quadratic. Multi-dimensional scattered mesh generation. Derivative approximations using various RBFs. Computational discretization for the first and second derivatives in one dimension, and two-dimensions. Error analysis and derivation of optimal shape parameter. Convergence theory associated with local RBF method. Convergent radial basis scattered mesh compact discretization for differential equations. The generalization of compact discretization based on radial basis function and scattered mesh points.

Neural network: Introduction to neural network, automatic differentiation, Function approximation by neural network, Differential equations as a neural network layers, Neural and universal differential equations, Multi-Layer network, Backpropagation algorithm, Stochastic

gradient descent algorithm, Neural network method for ordinary differential equations, Legendre neural network, Numerical simulations.

**Reading suggestions:**


- H. P. Langtangen A Primer on Scientific Programming with Python, Springer, 2014
- I. Perfilieva, Fuzzy transforms, Transactions on rough sets. Springer, 2004.
- M.E. Biancolini, Fast Radial Basis Functions for Engineering Applications, Springer, 2017.
- P. Kim, MATLAB Deep Learning: With Machine Learning, Neural Networks and Artificial Intelligence, Apress, 2017.


**Evaluation and weightage:**

- 40% for Mid-Term examination,
- 40% for End-Term examination,
- 20% for Quiz/assignment/Practical