

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

Course Code	AM 603
Course Title	Robust Numerical Methods for Singularly Perturbed Problems
Course Credits	04

Course Objectives:

To give understanding of the singularly perturbed problems and issues in the development of numerical methods for this class of problems.

Minimum Pre-requisites:

Theory and numerics of ordinary and partial differential equations.

Course structure:

Unit-I

Introduction and motivation for the singularly perturbed problems: Regular and singular perturbation, some examples of singularly perturbed problems, Analytical behavior of the solutions of the singularly perturbed problems, Asymptotic expansions (brief description), Turning point problems.

Unit-II

Basic notions and issues in numeric for the problems with boundary layers: Location and width of a boundary layer, Norms for boundary layer functions, Issues in implementation of standard numerical for singularly perturbed problems, Parameter uniform methods for singularly perturbed problems.

Unit-III

Robust numerical methods for singularly perturbed problems: Some a priori estimates for singularly perturbed problems, Fitted operator methods on uniform mesh, Fitted mesh methods on piece-wise uniform and non-uniform meshes and their convergence analysis.

Reading Suggestions:

- J. J. H. Miller, E. O'Riordan, and G. I. Shishkin. Fitted Numerical Methods for Singular Perturbation Problems: Error Estimates in

the Maximum Norm for Linear Problems in One and Two Dimensions. World Scientific, 2012.

- H. G. Roos, M. Stynes, L. Tobiska, Robust Numerical Methods for Singularly Perturbed Differential equations, Convection-Diffusion-Reaction and Flow problems, Springer, 1996.
- P. A. Farrell, A. F. Hegarty, J. J. H. Miller, E O'Riordon, G. I. Shishkin, Robust Computational Techniques for Boundary Layers, Chapman and Hall, CRC Press, Boca Raton, USA 2000.
- A. H. Nayfeh, Perturbation Methods, Wiley, New York 1973.
- R. E. O'Malley Jr. Singular Perturbation Methods for Ordinary Differential Equations, Springer Verlag, 1991.
- E. P. Doolan, J. J. H. Miller, and W. H. A. Schilders. Uniform numerical methods for problems with initial and boundary layers, volume 1. Boole Press, Dublin, 1980.
- M. H. Holmes, Introduction to Perturbation Methods, Springer, 1998.

Evaluation and weightage:

- Mid-Term Evaluation Examination: 20%
- Presentations: 40%
- End-Term Evaluation: 40%