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INTRODUCTION TO SINGULARLY PERTURBED DIFFERENTIAL EQUATIONS

Mathematical preliminaries: Little-oh, Big-oh, Asymptotically equal to or behaves like notations, Asymptotic sequences and asymptotic expansions, Convergent series versus divergent series, Asymptotic expansions with a parameter, Uniformity or breakdown, Intermediate variables and the overlap region, the matching principle, matching with logarithmic terms, composite expansions.

Introductory applications: Roots of equations, integration of functions represented by asymptotic expansions, ordinary differential equations: regular problems, simple singular problems, scaling of differential equations, equations which exhibit a boundary layer behavior, where is the boundary layer?

Motivation for the study of Singular Perturbation Problems (SPP)-- Asymptotic expansion and approximation, asymptotic solution of algebraic and transcendental equations, regular and singular perturbations for first and second-order ordinary differential equations, physical examples.

Two-point boundary-value problems- Boundary layers -exponential and cusp layers, matched asymptotic expansions, composite asymptotic expansions. WKB (Wentzel, Kramers, Brillouin) expansion method- conditions for validity of the WKB approximation, patched asymptotic approximations, WKB solution of inhomogeneous ordinary differential equations.

Boundary layers and transition layers. The method of multiple scales: Nearly linear oscillations, nonlinear oscillators, applications to classical ordinary differential equations, WKB method for slowly varying oscillations, turning point problem, applications to partial differential equations, limitation on the use of the method of multiple scales, boundary layer problems. Some physical applications of singular perturbation problems:

Reference books

1.C.M. Bender, S.A. Orszag, Advanced Mathematical Methods for Scientists and Engineers, Springer, New York, 1999.

2. A.H. Nayfeh, Introduction to Perturbation Techniques, John Wiley & Sons, New York, 1981.

3. R.E. O'Malley, Singular Perturbation Methods for Ordinary Differential Equations, Springer-Verlag, New York, 1991.

4. Lawrence C. Evans, Partial Differential Equations, Graduate Studies in Mathematics, Vol. 19, American Mathematical Society, Providence, 1998

5. Robert C. Mc Owen, Partial Differential Equations - Methods and Applications, Pearson Education Inc., Indian Reprint 2004.

6. G. F. Simmons and S. G. Krantz, Differential Equations: Theory, Technique, and Practice, McGraw Hill, 2006.

7. E. A. Coddington, An Introduction to Ordinary Differential Equations, Prentice Hall India, 1995.

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