MA863 Introduction to Singular Perturbation Theory 3-0-0 3

COURSE OUTCOMES

CO1	The learner will have an understanding of fundamental solution of hyperbolic and elliptic equations and other solution methods of PDE.
CO2	The learner will be able to analyze the aymptotic approximation of eigen value problems and partial differential equations and apply the method of strained coordinates to their own research problems.
CO3	The learner will have an understanding of regular and singular perturbation and ready to work with their research problem based on Hopf bifurcation.
CO4	The learner will be able to analyze the numerical solutions of singular perturbation problem and carry out the research using WKB approximations and homogenization theory.

UNIT I **15 periods**

Partial Differential Equations

Theory of distributions in n dimensions, fundamental solutions to Laplace, wave and heat equations in 1D , 2D and 3D - Construction of Green's functions for Laplace, wave and heat equations using method of images, partial transforms, complete transforms, eigenfunction expansions.

UNIT II **15 periods**

Regular Perturbation Theory

Asymptotic approximations - regular perturbation for roots of a polynomial, differential equations, eigenvalue problems and partial differential equations; method of strained coordinates - eigenvalues of nonlinear boundary-value problems; stationary and Hopf bifurcations.

UNIT III **15 periods**

Singular perturbation theory

Multiple scales analysis- singular perturbation theory for algebraic equations, boundary layer problems – singular perturbation theory for nonlinear dynamics - WKB approximation – homogenization theory.

REFERENCE BOOKS

1. Kevorkian and Cole, Multiple Scale and Singular Perturbation Methods.
2. AH Nayfeh (1993), Introduction to perturbation techniques, Jhon wiley and sons ,Newyork, USA.
3. Samuel. D. Conte, Carl. De Boor, Elementary Numerical Analysis, Mc Graw-Hill International Edn., 1983.
4. Gordon D Smith, Numerical Solution of Partial Differential Equations – Finite Difference Methods, Oxford University Press, 1985.
5. M. Stynes H. G Roos and L. Tobiska (2010), Numerical Methods for Singularly Petrubed Differential Equations Convection-Diffusion and Flow Problems. Springer Verlag.

6. P.A. Farrell, A.F. Hegarty, J.J.H.Miller, E. O'Riordan, G.I. Shishkin, Robust computational techniques for boundary layers, Chapman Hall/ CRC, Boca Raton, 2000.
7. E.P. Doolan, J.J.H.Miller, W.H.A. Schilders, Uniform numerical methods for problems with initial and boundary layers, Boole, Dublin, 1980.
8. R.E. O'Malley, Singular perturbation methods for ordinary differential equations, Springer, New York, 1990.

Evaluation Pattern:

There will be two periodical test will be conducted for internal assessment as follows:
Periodical Test- 1 - 15 marks
Periodical Test - 2- 15 marks

Continuous Assessment - 20 marks (Quizzes / assignments)

At the end of the course, there will be two hour exam as End semester- 50 marks.

Skill Development:

To help the learners understand the Quantitative as well as Qualitative analysis of solution of regular and singular perturbation problems. To prepare the learners to understand the computational thoughts and apply new computational schemes for deriving the apriari and posteriori error estimates to singularly perturbed problems.

To prepare the learners work with new hybrid methods for their research problems and analyze the approximation of solution, its stability, convergence of computational methods.