MATHEMATICAL METHODS FOR BOUNDARY VALUE PROBLEMS

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PRE-REQUISITES :   Basic UG course in Mathematics/ Undergraduate Calculus

INTENDED AUDIENCE : Undergraduates of any Engineering course, Mathematics, Physics and Postgraduate student of Mathematics/ Mechanical/ Aerospace/Chemical Engineering

COURSE OUTLINE :

This course is intended to provide methods to solve linear and nonlinear boundary value problems involving ordinary as well as partial differential equations. The course will start providing mathematical tools based on integral transformation, Fourier series solution and Greens function for obtaining analytic solutions for BVPs. The applicability of the BVP in several practical contexts, e.g. boundary layer flow, transport phenomena and population balance models will be made. Numerical solutions based on the shooting methods will be introduced. Finite difference methods for linear BVP of second-order and higher orders will be discussed. Iterative techniques to solve nonlinear BVP are included in this course. Algorithms for block tri-diagonal system to handle higher order and system of BVPs will be discussed. Computation of elliptic type of PDEs arises in diffusion dominated process will be described. All the methods will be illustrated by working out several examples. This course, apart from being a part of regular undergraduate/ postgraduate mathematics course, will provide a guidance to solve BVPs arise in mathematical modeling of several transport phenomena. Pre-requisite for this course should be the basic knowledge of undergraduate calculus.

ABOUT INSTRUCTOR :

Prof. S. Bhattacharyya is a senior professor in the Department of Mathematics, IIT Kharagpur. His specialization is Applied Mathematics. He is teaching courses on Integral Transform Techniques, Partial Differential Equations, Numerical solutions of PDEs and other related courses on a regular basis for the B.Tech students at IIT Khargpur for the past 26 years. His research works involve numerical solutions of PDEs and he has published more than 120 research papers in reputed international journals. He has undertaken several sponsored research projects and guided 15 PhD students. Prof. Bhattcahrayya has organized and delivered lectures in several Conferences, AICTE sponsored short term courses and GIAN courses on the topics related to Applied Mathematics. He has received several fellowships for research collaboration in USA, UK and Germany.

COURSE PLAN :

Week 1: Boundary Value Problems (BVP); Strum-Liouville Problems; Eigen Values, Eigen Functions. Solution of homogeneous/ non-homogeneous BVPs by Eigen function expansion.

Week 2: Eigen function expansion techniques for PDEs; Green's function; Dirichlet Problems;   Maximum Principle.

Week 3: Numerical Techniques for BVP: Shooting Method; Finite Difference Method; Block tri-diagonal system of equations; Numerical Methods for Non-linear BVPs

Week 4: Finite difference method for PDEs; Stability analysis; Crank-Nicolson Scheme; ADI scheme; Elliptic type of Partial Differential Equations; Successive-Over-Relaxation Method.