Date of Examination : _____ Session (FN/AN) _____ Duration __2 hrs__

Subject No. : __Advanced Numerical Techniques__   Subject Name : __MA 3011__

Department/Center/School : __MATHEMATICS__

Special Instructions (if any) : __Answer ALL the Questions__

__Marks are indicated within the parenthesis__

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1. Obtain second-order accurate forward difference and backward difference formula for a first-order derivative.

   Use the above formulae to discretize the boundary conditions and obtain a second-order accurate solution for the following BVP when h=0.25

   $$\frac{d^2y}{dx^2} - 2x\frac{dy}{dx} - 2y = -4x; \quad y(0) - y'(0) = 0 \ \& \ 2y(1) - y'(1) = 1.$$ [4+6]

2. Describe an iterative method to solve the following nonlinear BVP by a second-order accurate finite difference technique

   $$\frac{d^3y}{dx^3} + 2y\frac{d^2y}{dx^2} + 1 - \left(\frac{dy}{dx}\right)^2 = 0; \quad y(0) = y'(0) = 0 \ \& \ y'(1) = 1.$$

   Derive the ensuing block tri-diagonal system of equations at each iteration level when the step size is h=0.2

   Describe an algorithm to solve the block tri-diagonal system of equations.

   Solutions are not required.   [4+3+3]

3a. Describe the cubic spline interpolation technique by deriving all the governing equations.

3b. Use the cubic spline interpolation technique to solve the following boundary value problem with h=0.5

   $$\frac{d^2y}{dx^2} + 2\frac{dy}{dx} + y = 30x; \quad y(0) = 0 \ \& \ y(1) = 0.$$ [5+5]

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