22.10.24

# AE508 HOMEWORK 1

SUBMISSION DUE DATE: 5TH NOV. 2024 13.30 – A13

Q1) For the given equation below:

$$U\frac{\partial f}{\partial x} = D\frac{\partial^2 f}{\partial x^2}$$

a) Use (i) central difference approximation, (ii) forward difference approximation for the left hand side of the equation. Right hand side will be central difference approximation for both (i) and (ii).
b) Rearrange them with cell Reynolds number, R = Uh/D, where U is velocity, h is the separation between grid points, D is the viscosity.
c) Solve the equations numerically in terms of only R.
d) Show the general solution for both approximations with appropriate boundary conditions.

Q2) Derive the first derivative's 3rd-order forward and backward difference approximations using polynomial fitting. Explain why these are particularly useful in certain scenarios.

Q3) Compare the truncation error of the 4th-order central-difference and 4th-order compact Padé schemes for the first derivative. Under what conditions might one prefer the compact scheme?

Q4) Analyze the performance of different finite-difference schemes (1st to 4th order) in solving the one-dimensional convection-diffusion equation. How does the choice of approximation for convection and diffusion terms affect the accuracy of the solution?

Q5) Write codes for 1D example (between slides 16-20) and 2D example (between slides 21-25) using any programming language. Apply all steps given in slides. Compare them.