ME543

Assignment 1

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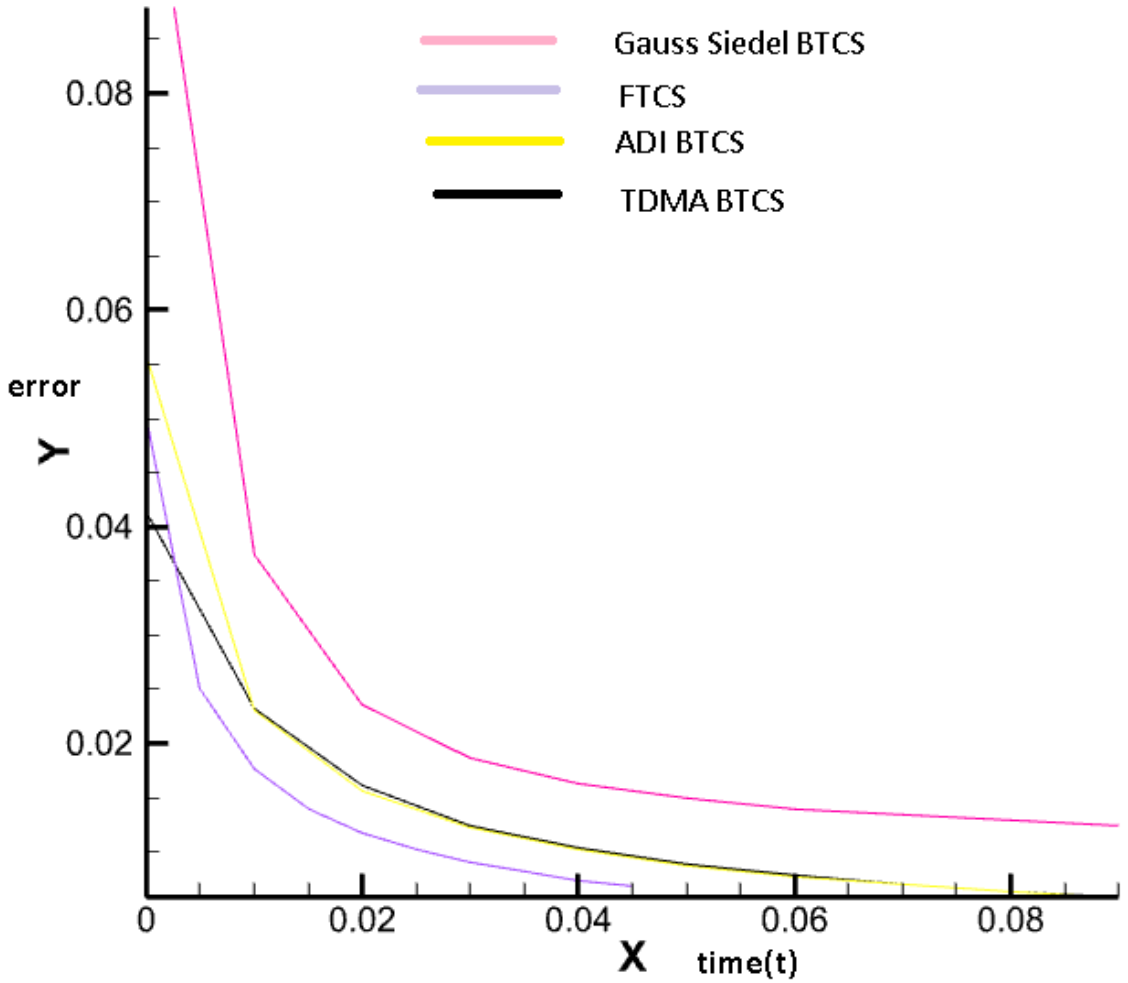
Couette Flow

$$\frac{\partial u}{\partial t} = \frac{1}{Re_H}\frac{\partial^2 u}{\partial y^2} \qquad Re_H = \frac{UH}{\nu} \qquad \epsilon = \sqrt{\frac{\sum_{j=1}^{M}(u^{n+1} - u^n)^2}{M}}$$

$\in = ¿\ 10^{-6}$

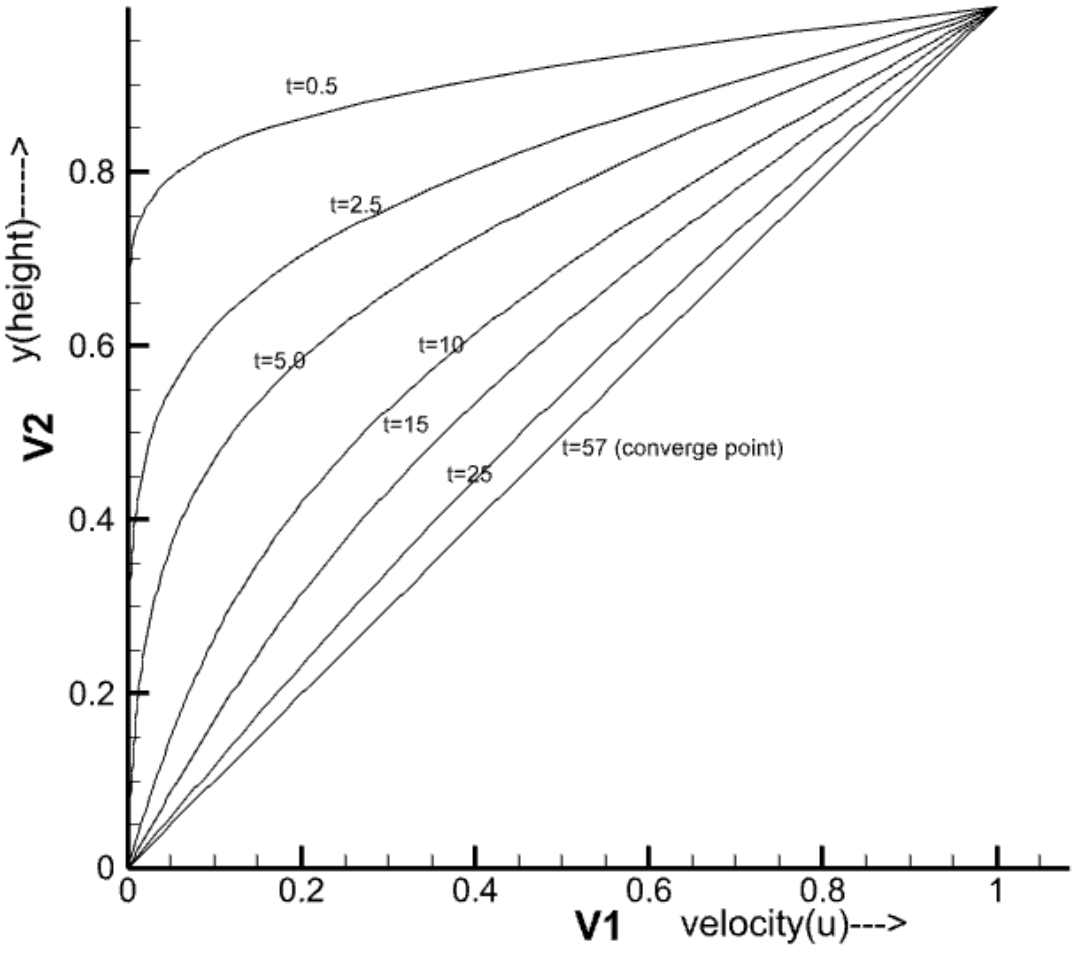


1. Explicit Method :- FTCS

$$u_i^{n+1} = u_i^n + \gamma\left(u_{i+1}^n - 2u_i^n + u_{i-1}^n\right)$$

$$\gamma = \frac{\Delta t}{\Re_H \Delta x^2} = 0.50$$

$\Re_H$**=100** $\Delta t = 5 \times 10^{-3}$ $\Delta x = 0.01$ **, M=100**



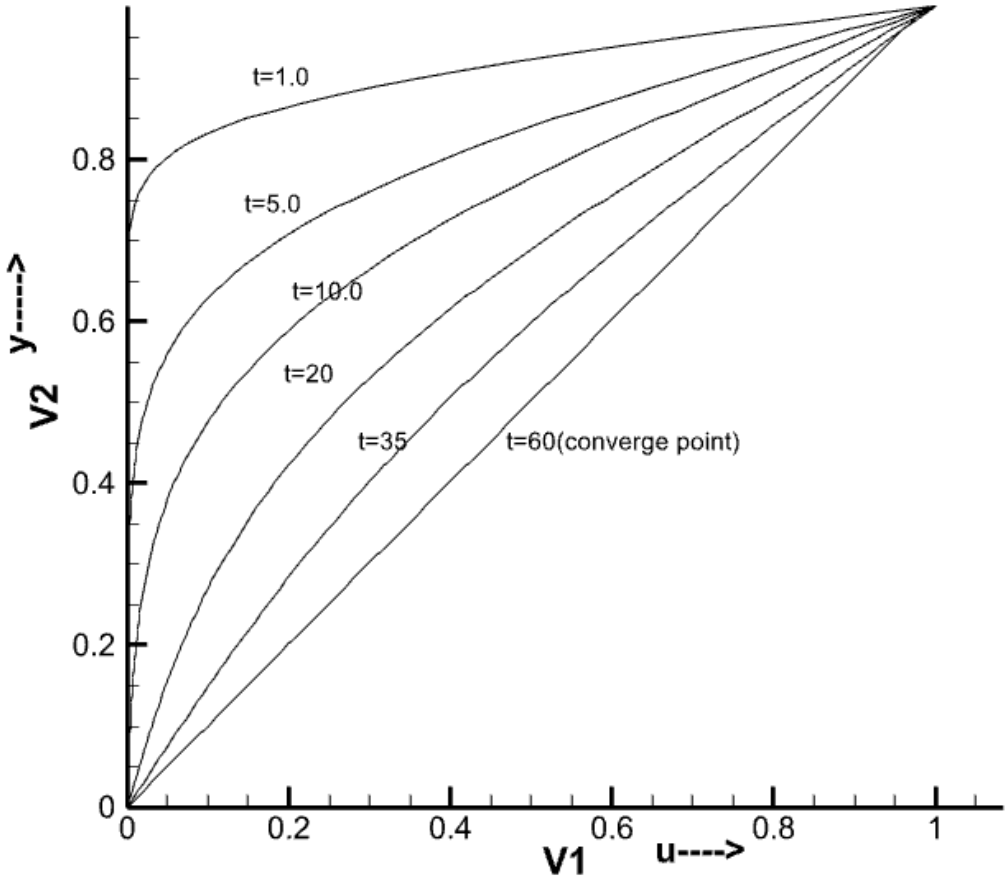
2. Implicite Methods :-

A. BTCS : Gauss- Siedel iterative method

$$\gamma u_{i+1}^{n+1} - (1+2\gamma) u_i^{n+1} + \gamma u_{i-1}^{n+1} = -u_i^n$$

$$\gamma = \frac{\Delta t}{\Re_H \Delta x^2} = 1.0$$

$\Re_H$**=100** $\Delta t = 10^{-2}$ $\Delta x = 0.01$ **, M=100**

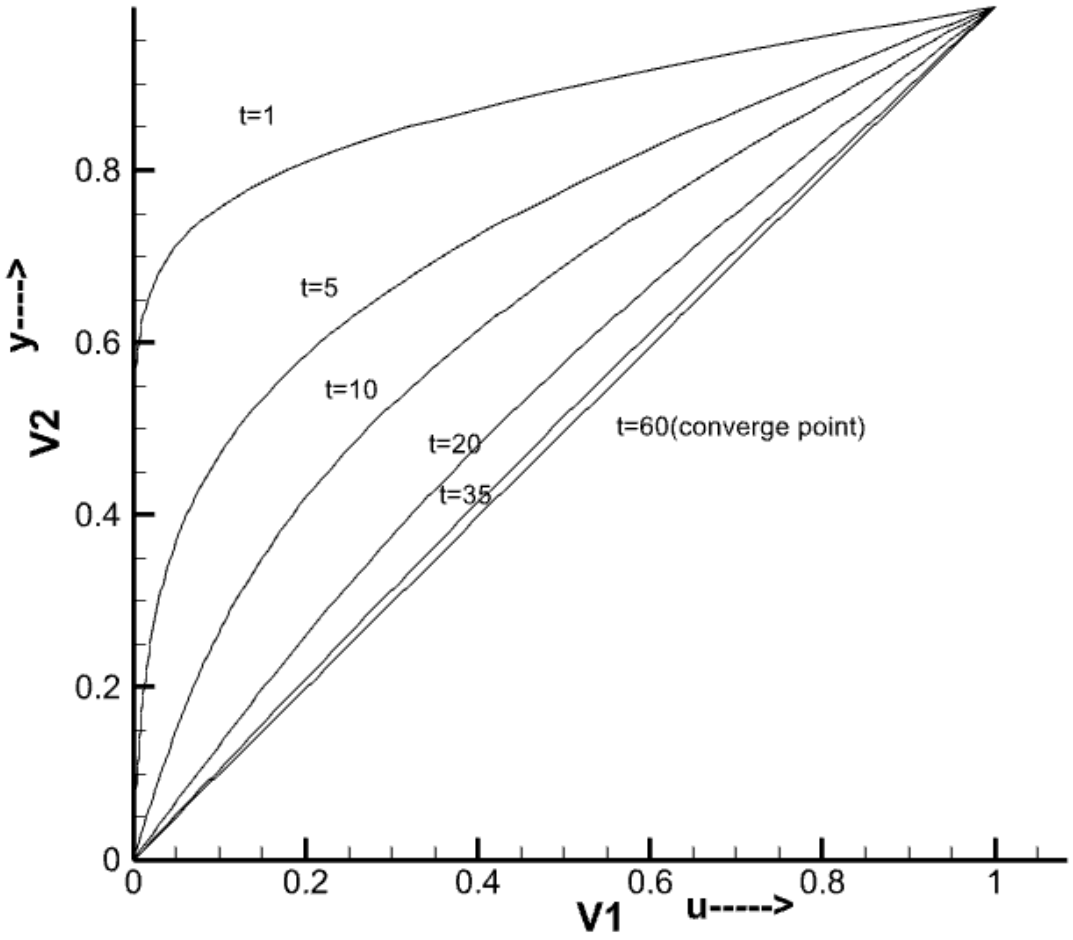


B. BTCS : TriDiagonal Matrix Algorithm

$$\gamma u_{i+1}^{n+1} - (1+2\gamma) u_i^{n+1} + \gamma u_{i-1}^{n+1} = -u_i^n$$

$$\gamma = \frac{\Delta t}{\Re_H \Delta x^2} = 1.0$$

$\Re_H$**=100** $\Delta t = 10^{-2}$ $\Delta x = 0.01$ **, M=100**



C. Crank – Nicolson: TriDiagonal Matrix Algorithm

$$\frac{\gamma}{2}u_{i+1}^{n+1}-(1+\gamma)u_i^{n+1}+\frac{\gamma}{2}u_{i-1}^{n+1}=-(\frac{\gamma}{2}u_{i+1}^{n}-(1-\gamma)u_i^{n}+\frac{\gamma}{2}u_{i-1}^{n})$$

$$\gamma=\frac{\Delta t}{\Re_H \Delta x^2}=1.0$$

$\Re_H$**=100** $\Delta t=10^{-2}$ $\Delta x=0.01$ **, M=100**