DEPARTMENT OF MATHEMATICS, I.I.T. GUWAHATI

MA 473: Computational Finance Lab – IV, January 31, 2018

1. Consider the following Black-Scholes PDE for European call:

$$\begin{cases} \dfrac{\partial V}{\partial t} + \dfrac{1}{2}\sigma^2 S^2 \dfrac{\partial^2 V}{\partial S^2} + (r-\delta) S \dfrac{\partial V}{\partial S} - rV = 0, \quad (0,\infty)\times(0,T],\ T>0 \\ V(S,t) = 0, \quad \text{for } S = 0, \\ V(S,t) = S - Ke^{-r(T-t)}, \quad \text{for } S\to\infty \\ \text{with suitable initial/terminal condition } V(S,0) \text{ or } V(S,T). \end{cases}$$

Solve the above Black-Scholes PDE by the following schemes:

(i) Forward-Euler for time & central difference for space (FTCS) scheme.
(ii) Backward-Euler for time & central difference for space (BTCS) scheme.
(iii) Crank-Nicolson finite difference scheme

The values of the parameters are $T = 1$, $K = 10$, $r = 0.06$, $\sigma = 0.3$ and $\delta = 0$.

To solve the system of linear algebraic equations arising from the implicit schemes use the iterative methods (Jacobi method, Gauß-Seidel method and SOR method).

2. Consider the following Black-Scholes PDE for European put:

$$\begin{cases} \dfrac{\partial V}{\partial t} + \dfrac{1}{2}\sigma^2 S^2 \dfrac{\partial^2 V}{\partial S^2} + (r-\delta) S \dfrac{\partial V}{\partial S} - rV = 0, \quad (0,\infty)\times(0,T],\ T>0 \\ V(S,t) = Ke^{-r(T-t)} - S, \quad \text{for } S = 0, \\ V(S,t) = 0, \quad \text{for } S\to\infty \\ \text{with suitable initial/terminal condition } V(S,0) \text{ or } V(S,T). \end{cases}$$

Solve the above Black-Scholes PDE by the following schemes:

(i) Forward-Euler for time & central difference for space (FTCS) scheme.
(ii) Backward-Euler for time & central difference for space (BTCS) scheme.
(iii) Crank-Nicolson finite difference scheme

The values of the parameters are $T = 1$, $K = 10$, $r = 0.06$, $\sigma = 0.3$.

To solve the system of linear algebraic equations arising from the implicit schemes use the iterative methods (Jacobi method, Gauß-Seidel method and SOR method).