Computational Finance MA473 Lab 01

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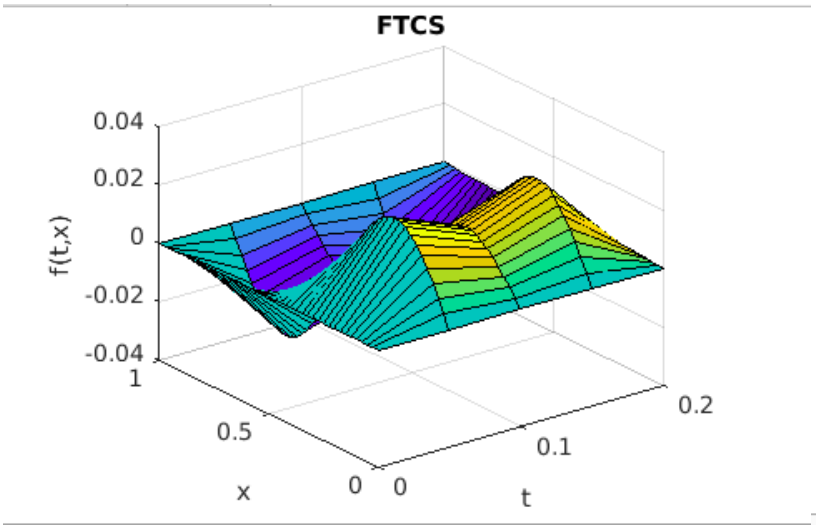
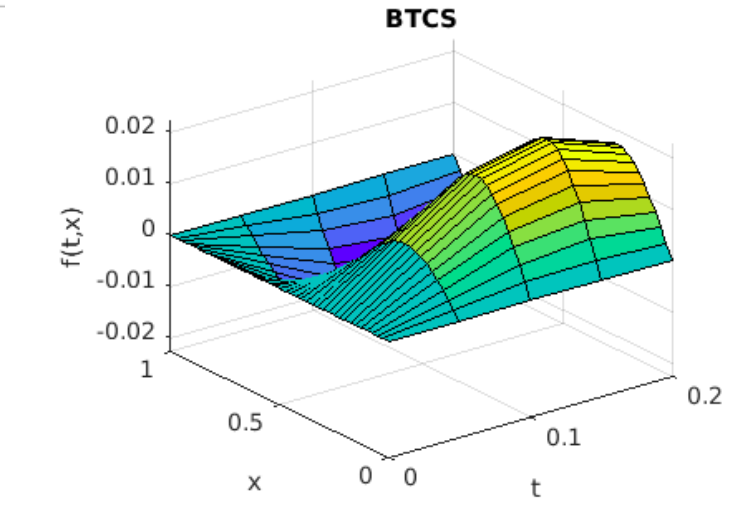
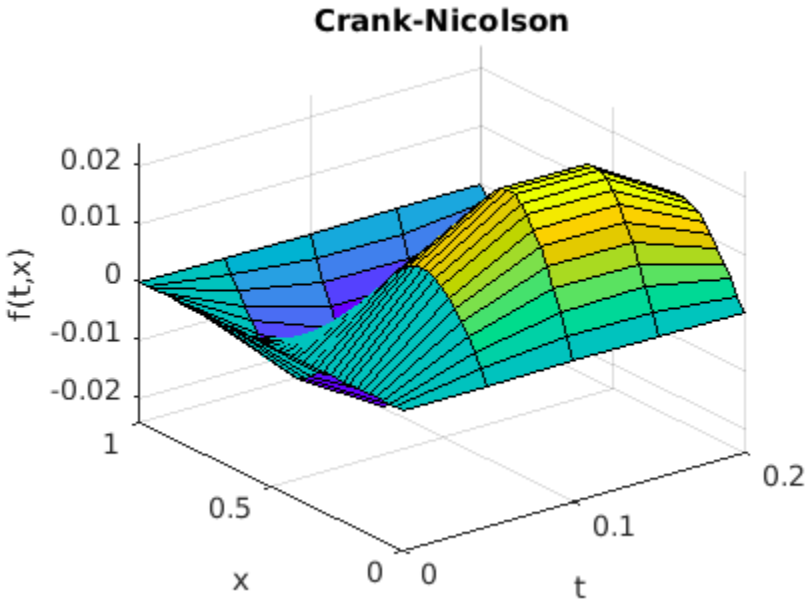
Ques.1



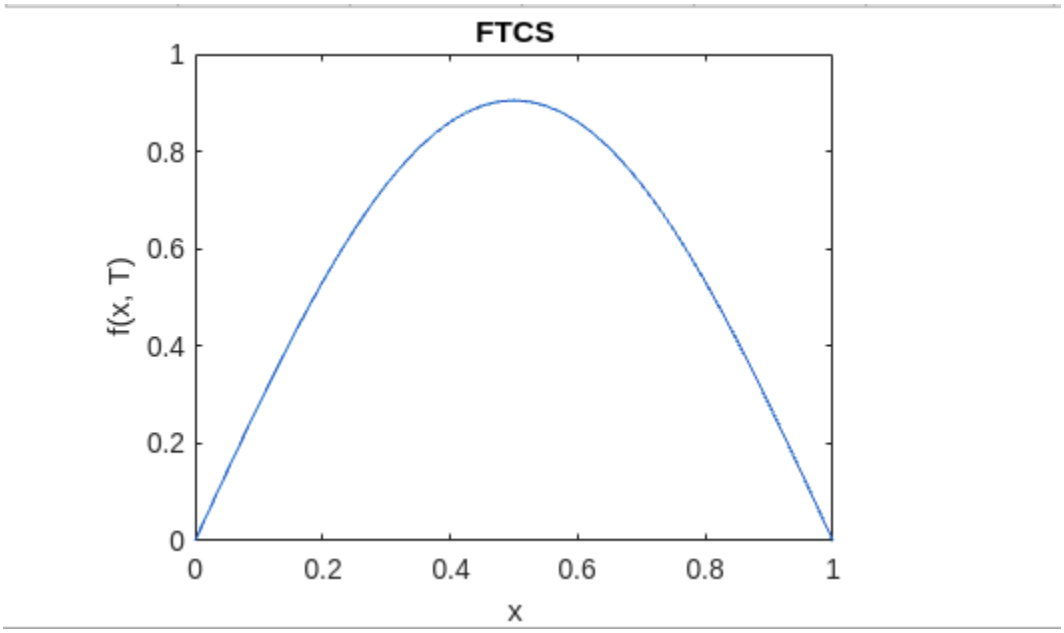


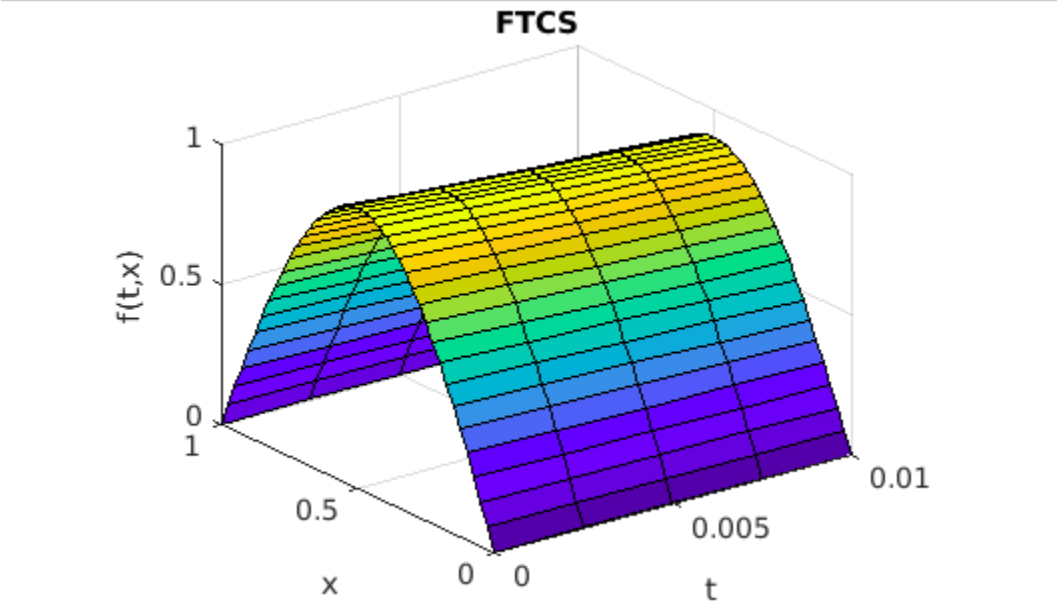


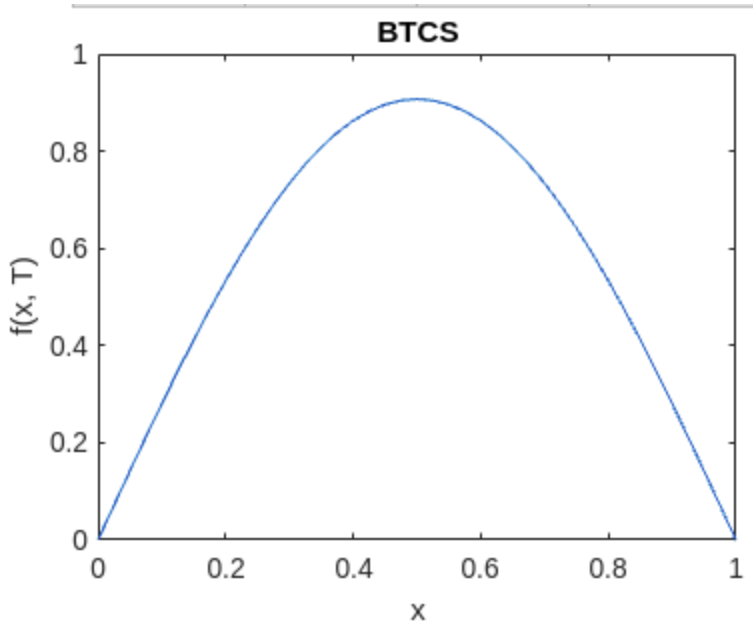
When there are N time points t and M space points x, the time complexity of FTCS is $O(NM)$. Assuming that the *backslash* solver of Matlab takes $O(M^3)$ time for a matrix of size MxM, the BTCS method takes $O(NM^3)$. Same $O(NM^3)$ time for Crank-Nicolson.

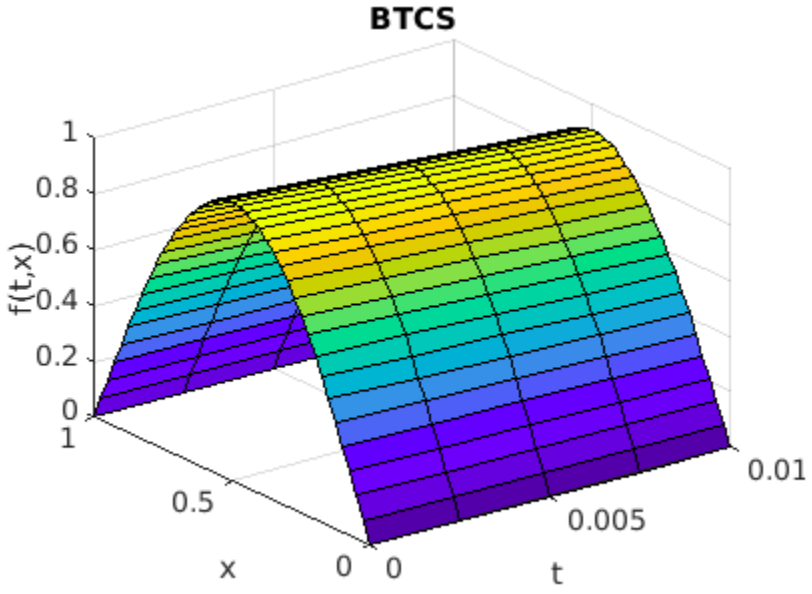
Ques.2

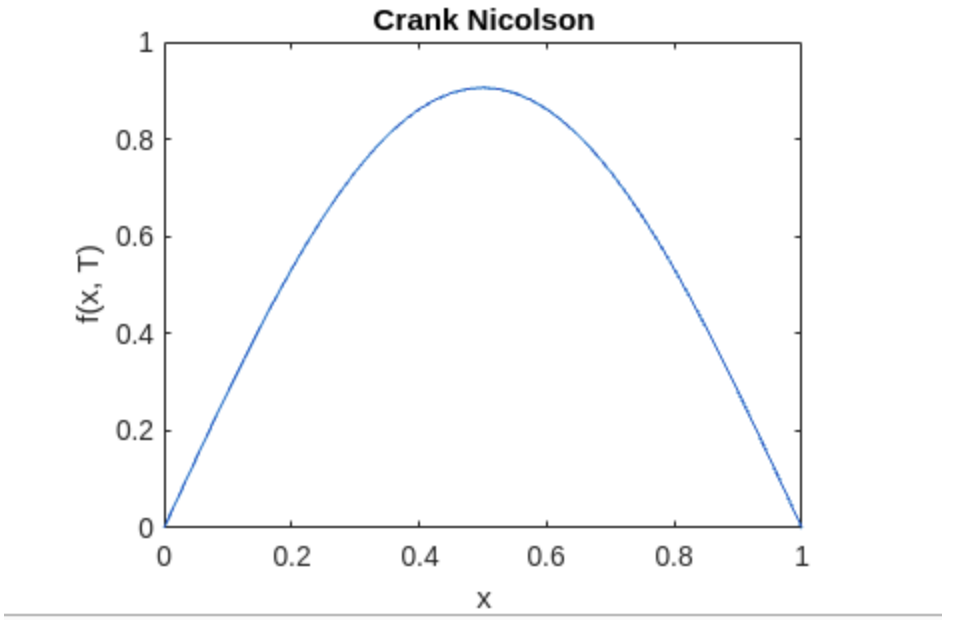
$$(a) f(x) = sin(\pi x)$$

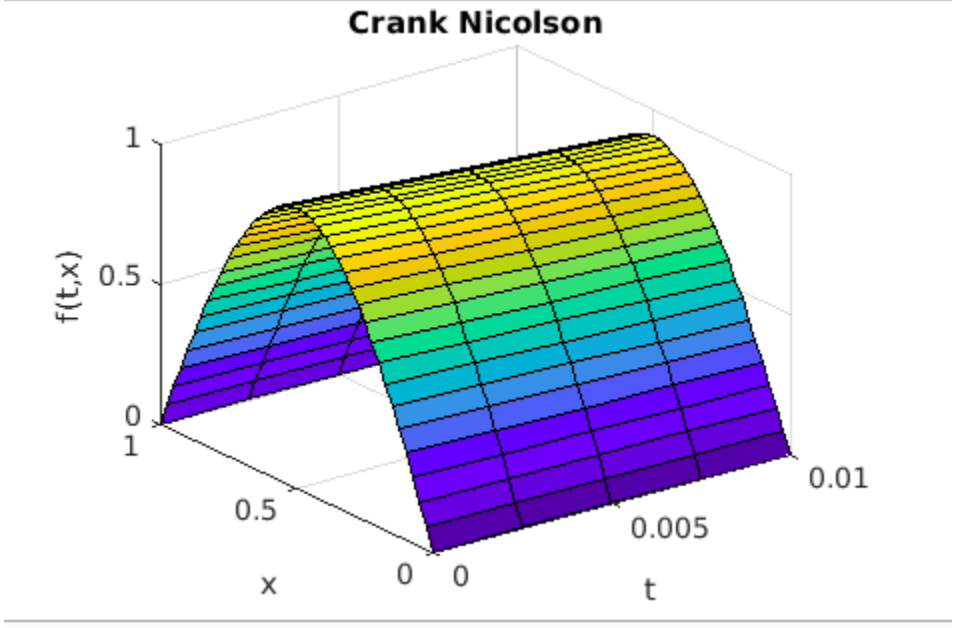




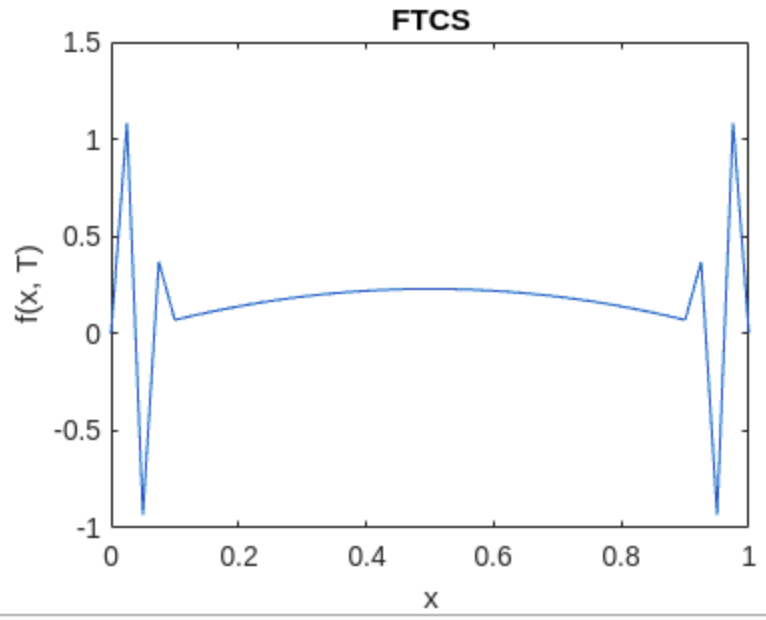

BTCS
f(x, T)
x
0
0.2
0.4
0.6
0.8
1

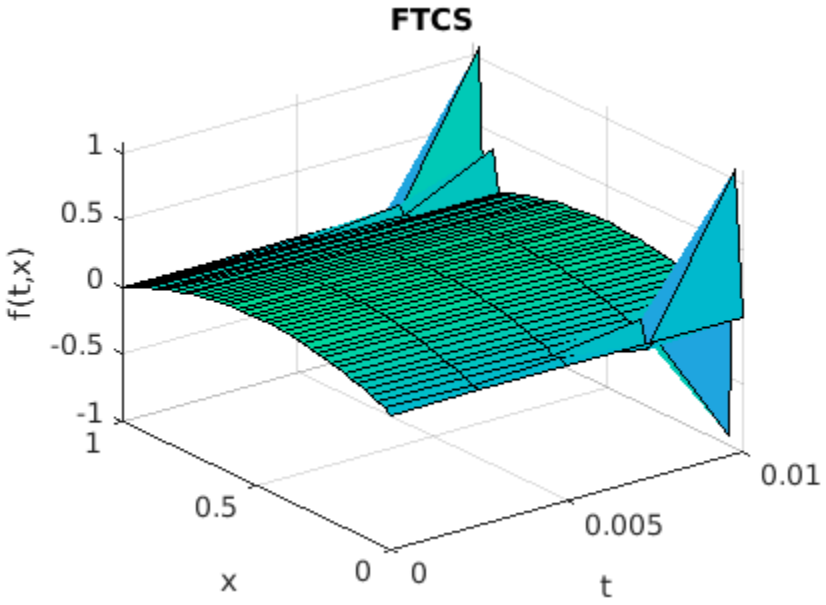

BTCS
f(t,x)
x
t
0
0.5
1
0.005
0.01

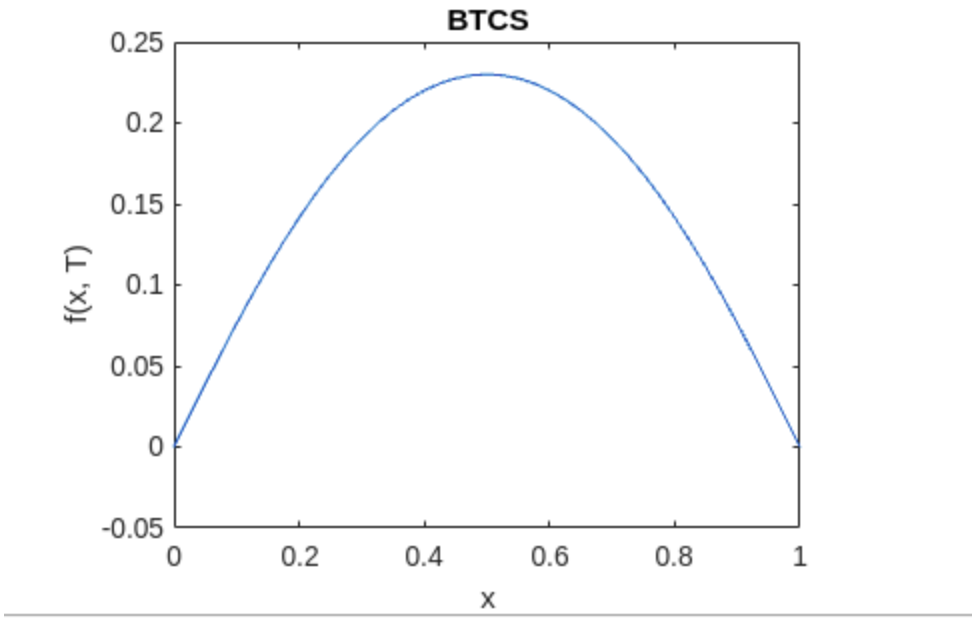

Crank Nicolson
f(x, T)
x
0
0.2
0.4
0.6
0.8
1

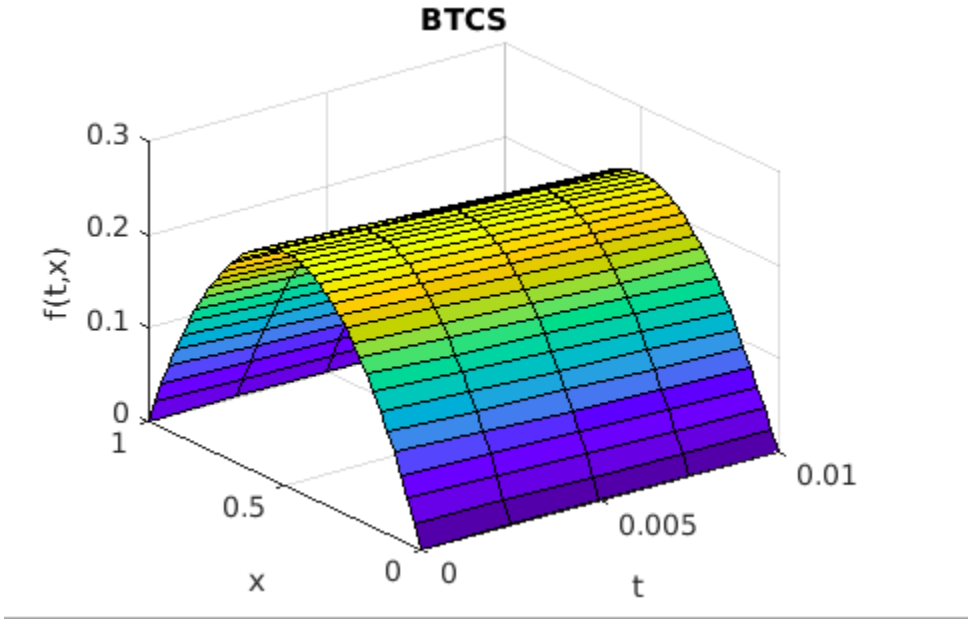

Crank Nicolson
f(t,x)
x
t
0
0.5
1
0.005
0.01

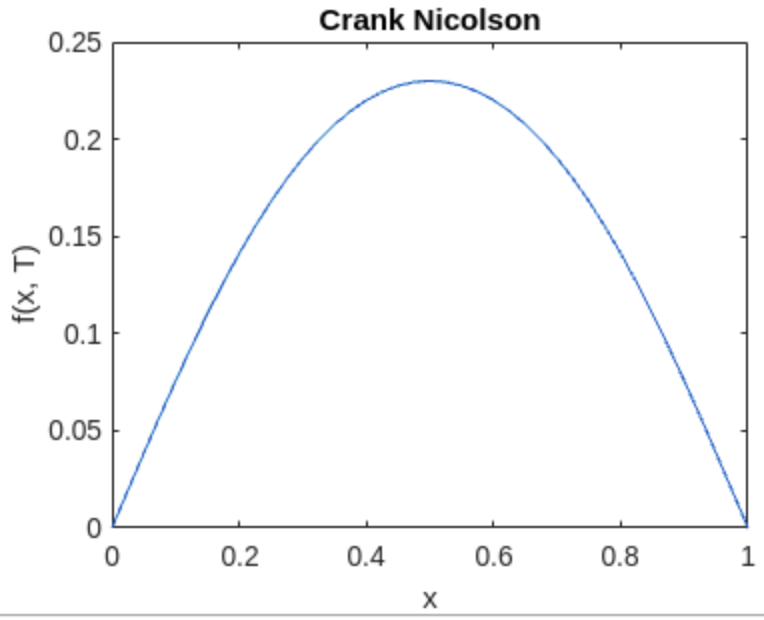
$$(b) f(x) = x(1-x)$$

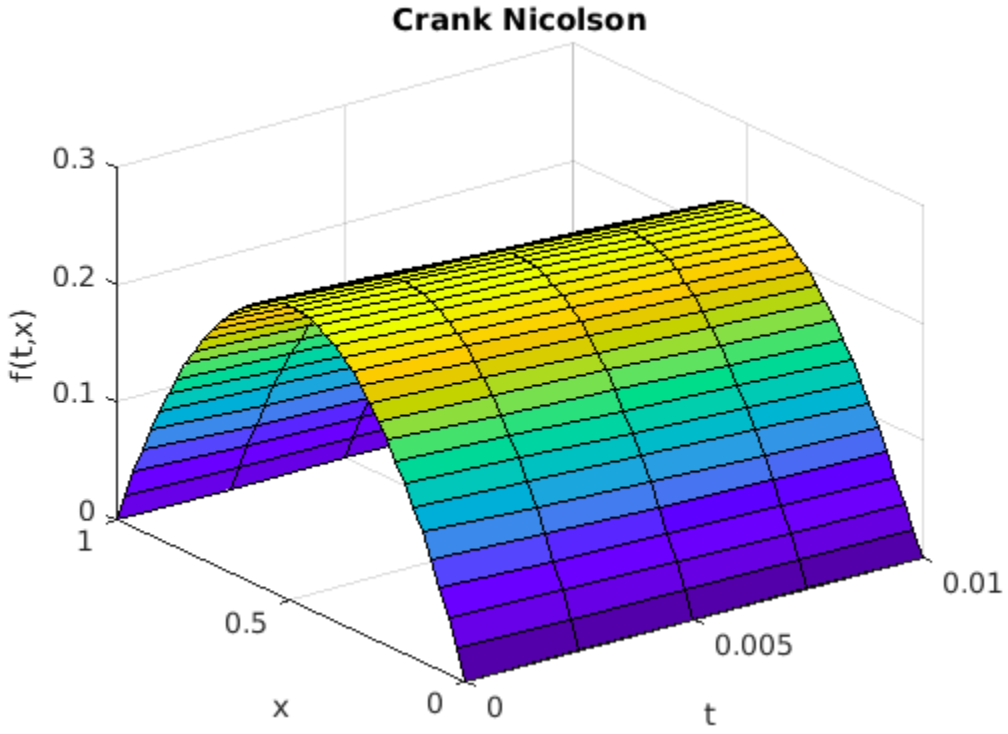

FTCS
1.5
1
0.5
0
-0.5
-1
f(x, T)
0
0.2
0.4
0.6
0.8
1
x


FTCS
1
0.5
0
-0.5
-1
f(t,x)
1
0.5
0
x
0
0.005
0.01
t


BTCS
0.25
0.2
0.15
0.1
0.05
0
-0.05
f(x, T)
0
0.2
0.4
0.6
0.8
1
x

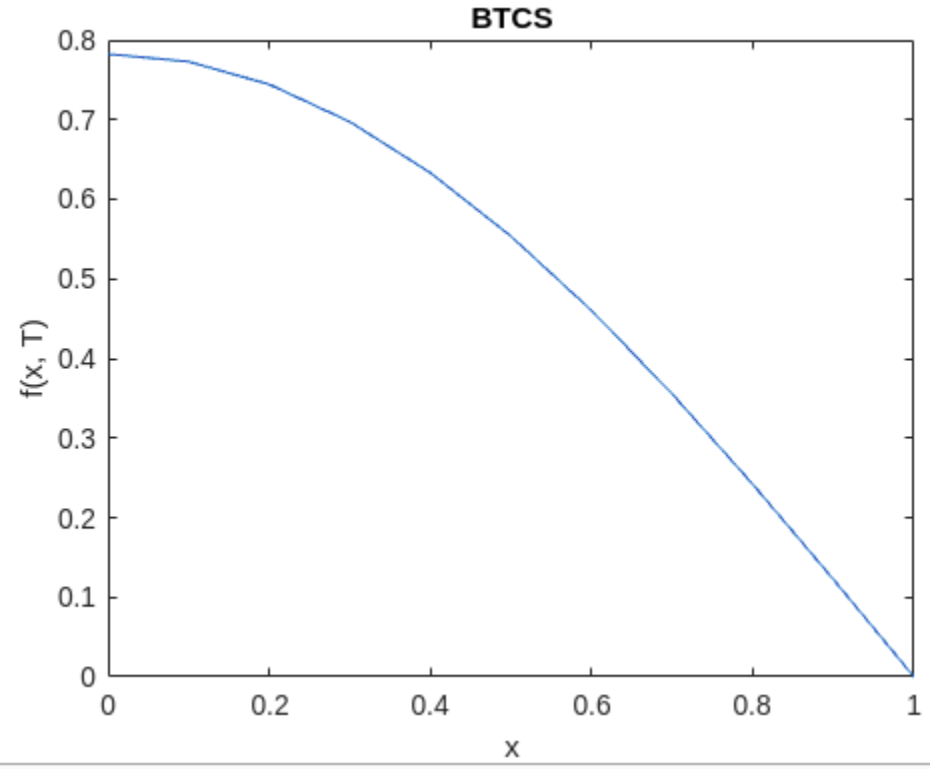

BTCS
0.3
0.2
0.1
0
f(t,x)
1
0.5
0
x
0
0.005
0.01
t

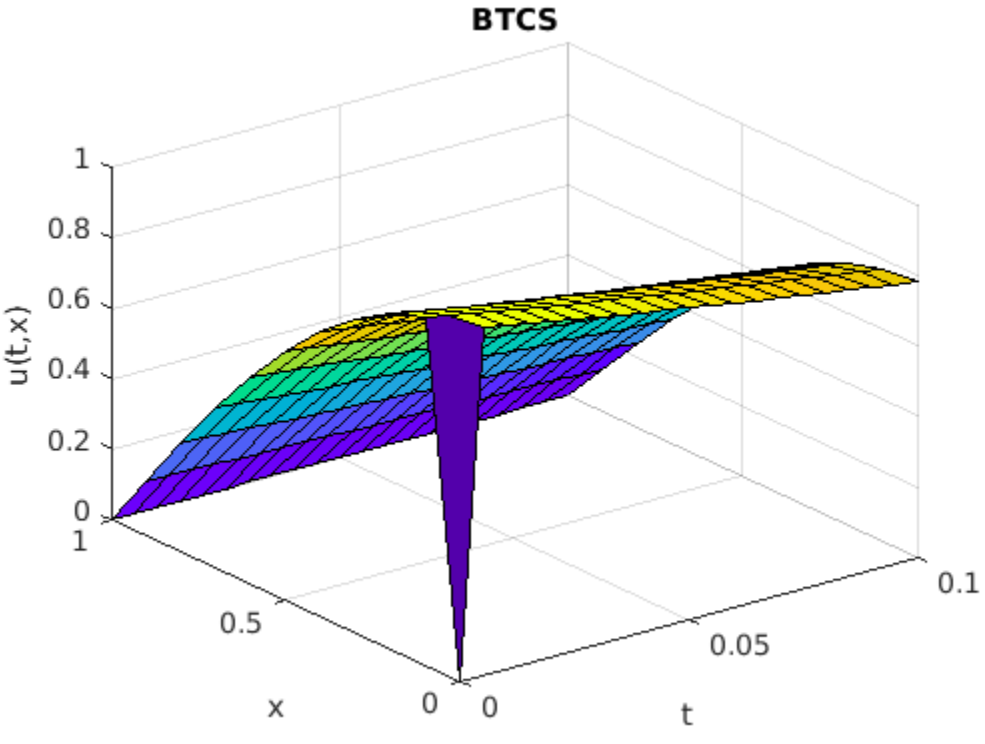


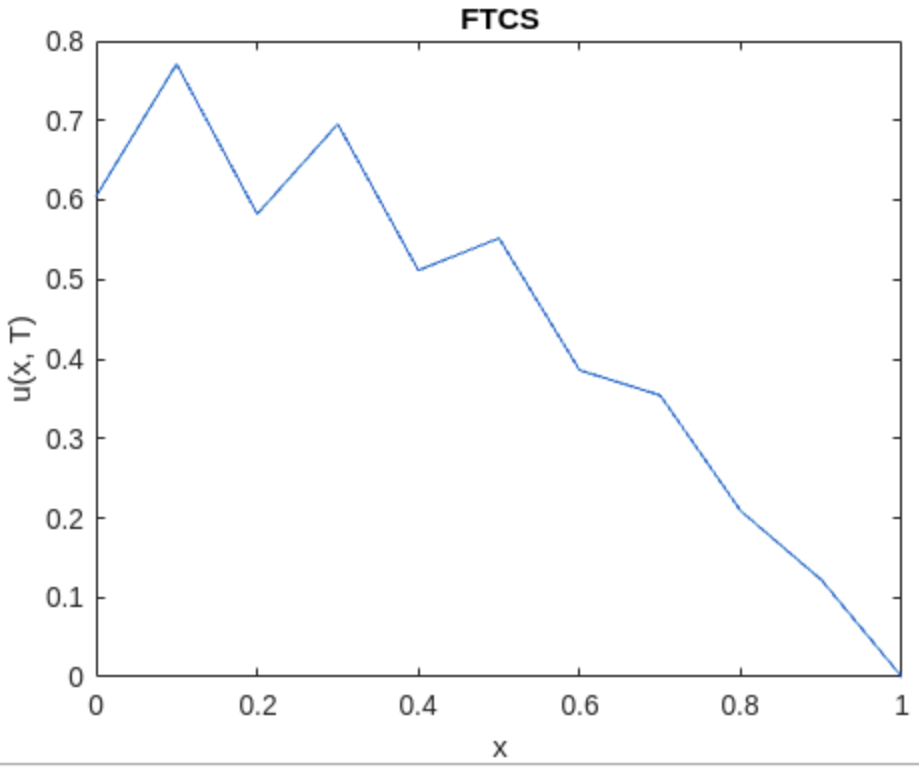


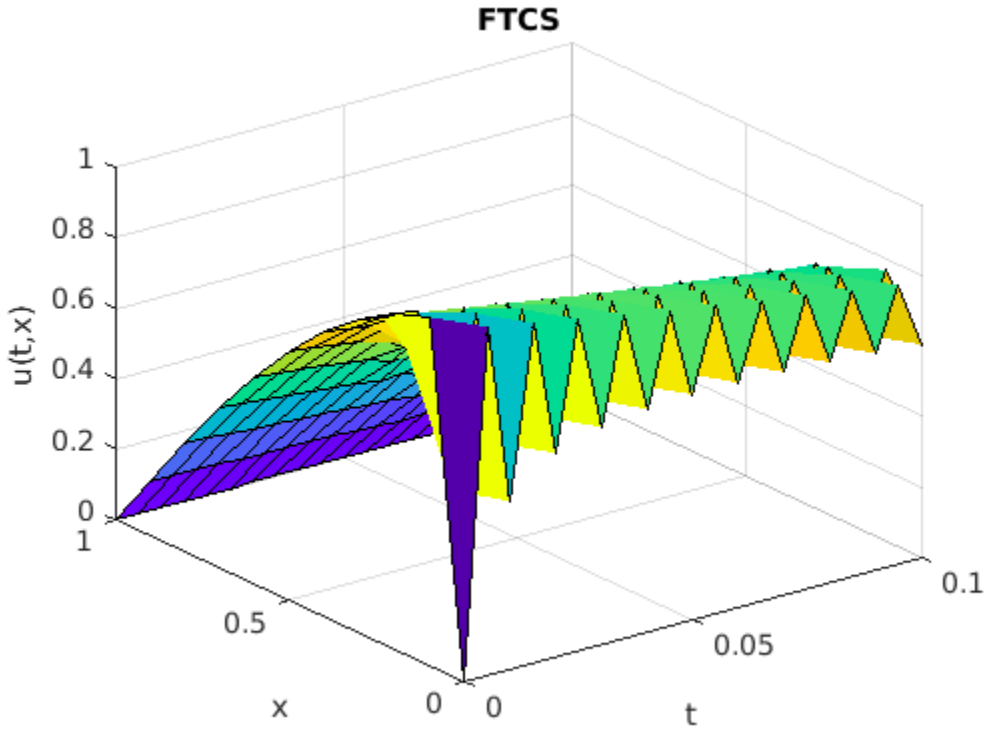
- The plots of FTCS will be very different because of our function x(1-x) because lambda = k/(h^2) is not less than ½ hence it's stability is violated and doesn't converge, hence errors are high.

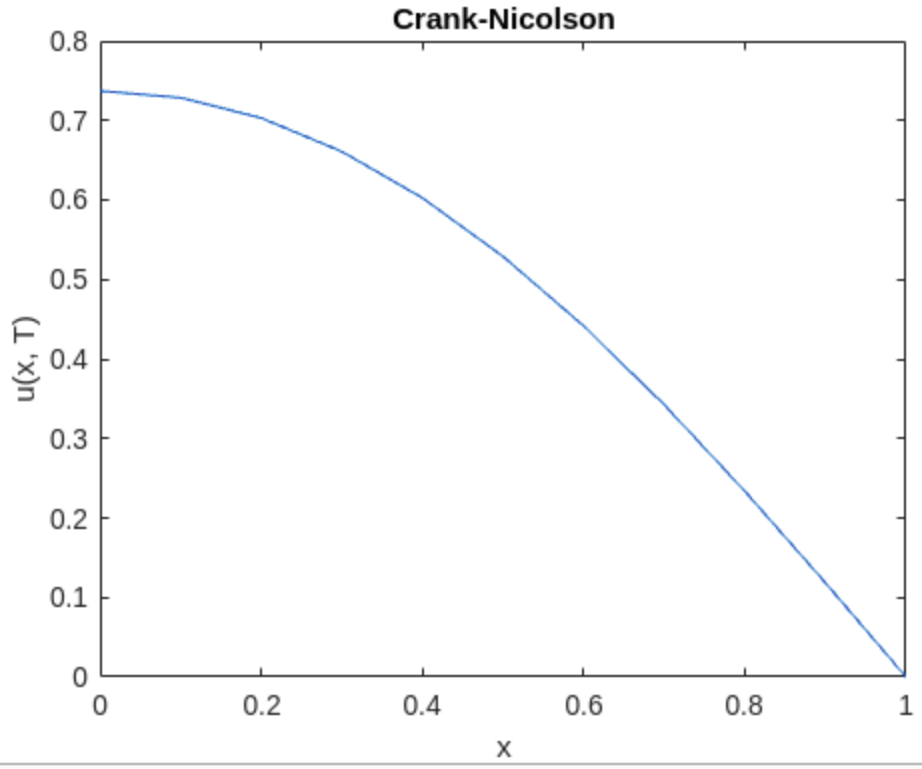
Ques.3

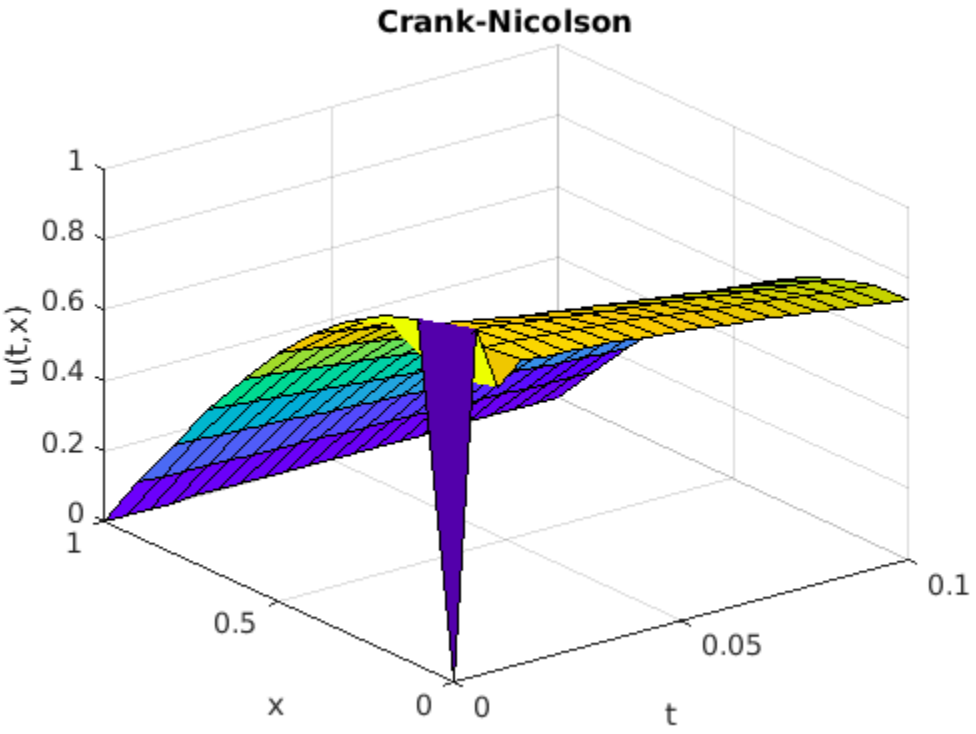

BTCS
f(x, T)
x
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0
0.2
0.4
0.6
0.8
1


BTCS
u(t,x)
x
t
0
0.2
0.4
0.6
0.8
1
0.5
0.05
0.1

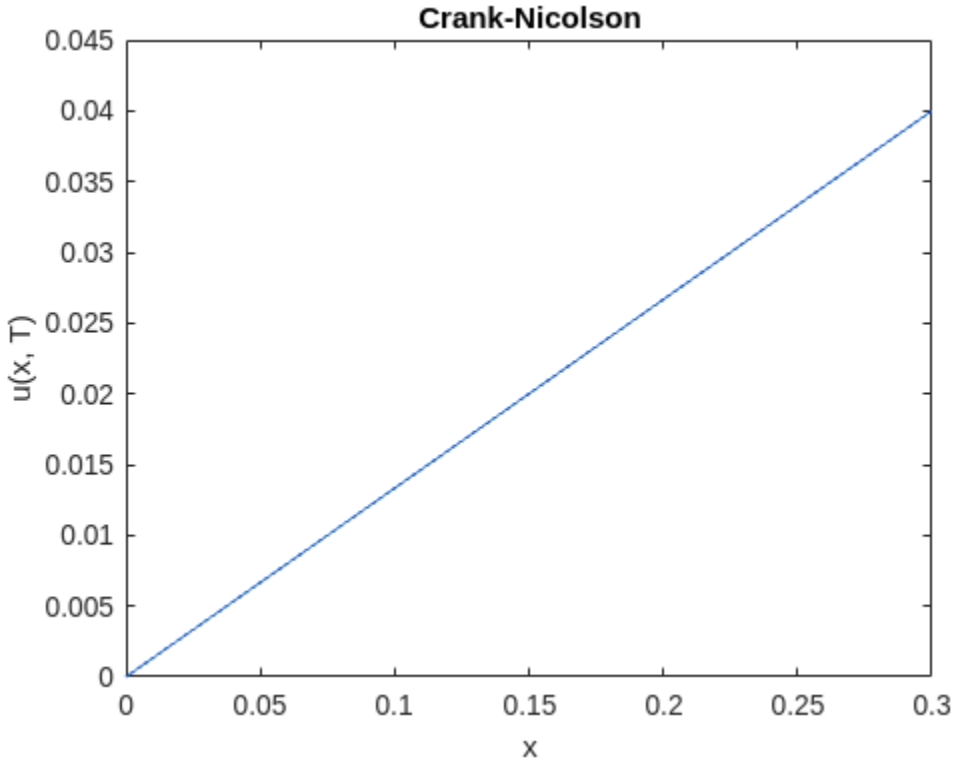

FTCS
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
u(x, T)
0
0.2
0.4
0.6
0.8
1
x

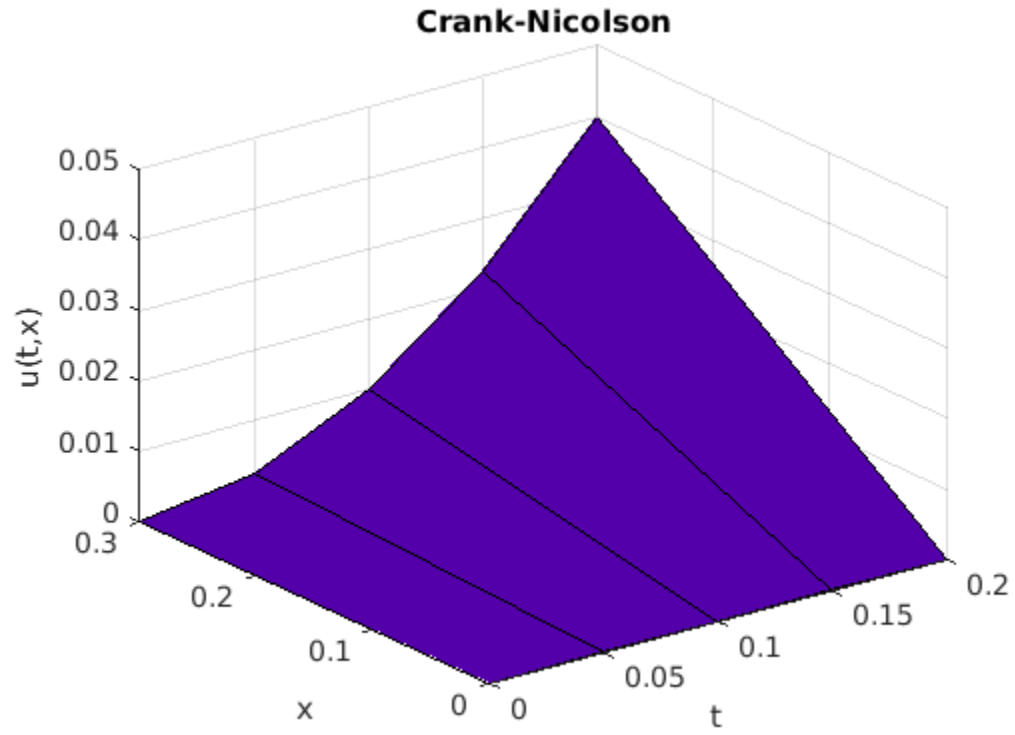

FTCS
1
0.8
0.6
0.4
0.2
0
u(t,x)
1
0.5
0
x
0
0.05
0.1
t


Crank-Nicolson
u(x, T)
x
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0
0.2
0.4
0.6
0.8
1


Crank-Nicolson
u(t,x)
x
t
0
0.2
0.4
0.6
0.8
1
0.5
0.05
0.1

Ques.4


Crank-Nicolson
0.045
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
u(x, T)
0
0.05
0.1
0.15
0.2
0.25
0.3
x


Crank-Nicolson
0.05
0.04
0.03
0.02
0.01
0
u(t,x)
0.3
0.2
0.1
0
x
0
0.05
0.1
0.15
0.2
t