Computational Mechanics Tools

Assignment 2: PDE-Toolbox

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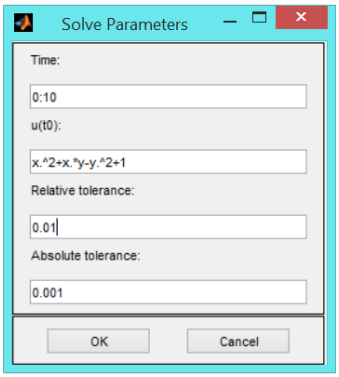
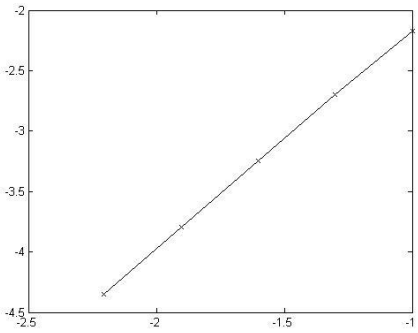
1. *Solve the problem and refine the initial mesh up to 4 times. Verify that the theoretical convergence order holds.*

With the predetermined time step and using the PDE Specification of a Parabolic solver (time dependent), it verifies that the convergence order holds in a straight line.

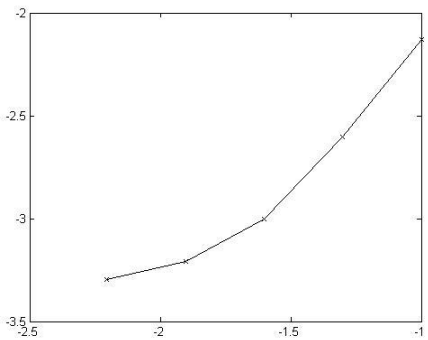




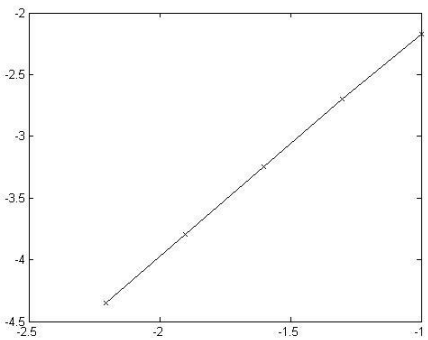
2. *How is the solution affected when we modify the final time?*

Convergence order:

for t = 1

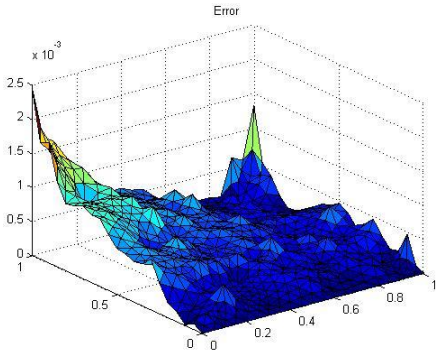


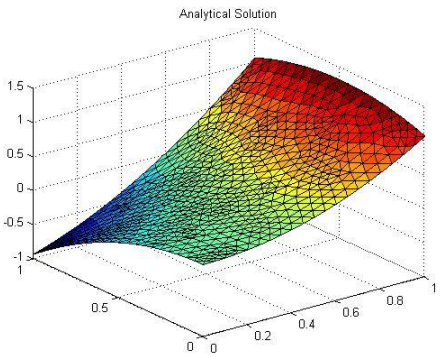
for t = 10

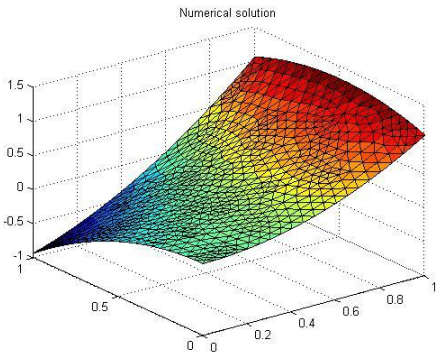


3D Plots

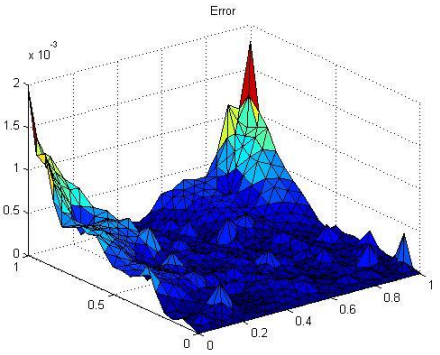
for t = 1

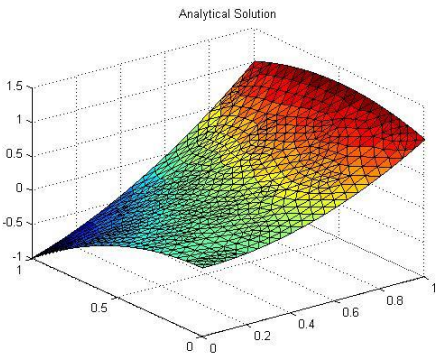


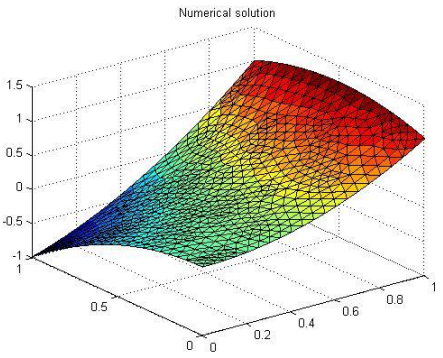




for t = 10







As it is shown there are some differences in the solutions and the errors, but the main affection of the final time is the velocity of the convergence, being better in the bigger time because we reach the stationary part of the EDP.

3. *We are interested in obtaining the solution at time tend = 50. Find a more efficient manner to solve this problem. You do not need to prove the equivalence mathematically, but you need to provide numerical evidence of the new method.*

In the problem, the only parameter that depends on the time is the exponential e^{-3t}, and for high values of "t" loses relevance until it goes to 0, changing the problem from Transitory to Stationary.

$$e^{-3\cdot 1} = 0.0498 \qquad e^{-3\cdot 10} = 9.35 \cdot 10^{-14} \qquad e^{-3\cdot 50} = 7.18 \cdot 10^{-66}$$

This change in the type of problem it could be implemented changing the PDE Specification from Parabolic (time dependent) to Elliptic (no time dependent) and considering the exponential $e^{-3t} = 0$.

With this table of the variation of the Max Error while refining the mesh we can observe that the results with the t=50 and the elliptics are exactly the same and very close to t=10, and that's because with t=10 → $e^{-3\cdot 10} = 9.35 \cdot 10^{-14}$ the solution is already Stationary.

h	0,1	0,05	0,025	0,0125	0,00625
t=1	0,0074	0,0025	0,0010	6,1728E-04	5,0617E-04
t=10	0,0067	0,0020	5,6787E-04	1,6004E-04	4,4423E-04
t=50	0,0067	0,0020	5,6788E-04	1,5992E-04	4,4414E-04
eliptic	0,0067	0,0020	5,6788E-04	1,5992E-04	4,4414E-04