**Assignment 4**

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# Example 6.7.1

## Inputs

The example input is for the Crank Nicolson Scheme, ie -

* alfa = 0.5
* DT = 0.05

The input example considers 8\*8 Linear rectangular element.

### Mesh Inputs

|  |  |
| --- | --- |
| **Parameter** | **Value** |
| NX | 8 |
| NY | 8 |
| NPE (Linear rectangular element) | 4 |
| NDF | 1 |

### Domain Dimension

The computational domain is a square of side 1 unit.

X0 and Y0 are the coordinates of the 1st node of 1st element

|  |  |
| --- | --- |
| **Parameter** | **Value** |
| x\_length | 1 |
| y\_length | 1 |
| X0 | 0 |
| Y0 | 0 |

**Time Simulation Parameter**

|  |  |
| --- | --- |
| **Parameter** | **Value** |
| DT | 0.05 |
| NTime | 25 |

**Differential Equation Parameter**

ITEM = 1 (Parabolic Equation)

ITEM = 2 (Hyperbolic Equation)

Assumed equations for A11, A22, A00 are same -

A11 = A10 + A1xX + A1yY + A1uU + A1uxdUdX + A1uydUdY

Assumed equation for C and F are same -

C = C0 + CxX + CyY

|  |  |
| --- | --- |
| **Parameter** | **Value** |
| ITEM | 1 |
| PDECOEFF.A11 | [1 0 0 0 0 0] |
| PDECOEFF.A22 | [1 0 0 0 0 0] |
| PDECOEFF.A00 | [0 0 0 0 0 0] |
| PDECOEFF.C | [1 0 0] |
| PDECOEFF.F | [1 0 0] |

**Simulation Parameters**

Considering Forward difference scheme

|  |  |
| --- | --- |
| **Parameter** | **Value** |
| NONLIN | 1 |
| ITMAX | 5 |
| Epsilon | 0.001 |
| NLS | 5 |
| alfa | 0.5 |
| GAMA | 0.5 |

GAMA is not used in this code, but it is mandatory to provide value of GAMA since it is passed in ELEMATRCS2D\_Time function (where it is not used for parabolic case)

**Essential Boundary Conditions**

|  |  |
| --- | --- |
| **Parameter** | **Value** |
| NSPV | 17 |
| ISPV | [9 1; 18 1; 27 1; 36 1; 45 1; 54 1; 63 1; 72 1;81 1; 80 1; 79 1; 78 1; 77 1; 76 1; 75 1; 74 1; 73 1] |
| VSPV | zeros(NSPV,1) |

**Natural Boundary Condition**

|  |  |
| --- | --- |
| **Parameter** | **Value** |
| NSSV | 15 |
| ISSV | [1 1; 2 1; 3 1; 4 1; 5 1; 6 1; 7 1; 8 1; 10 1; 19 1; 28 1; 37 1; 46 1; 55 1; 64 1] |
| VSSV | zeros(NSSV,1) |

**Additional Input**

This is an optional input, it can be used if you just want to check the values of time steps that is a subset of all the time steps.

For example, if my DT = 0.001 but I want to check the values after every 0.05sec.

Input an array of time step that you want to check to Check\_Time variable. Note - make Check\_Time = 0 if you want to see values at every time step

|  |  |
| --- | --- |
| **Parameter** | **Value** |
| Check\_Time | [0.05:0.05:1.00 1.25] |

### Result Table

### Table Description automatically generated

The blue line for Crank Nicolson is behind the grey line of Backward difference, that why it is difficult to see. This holds for almost all of the graphs

# Example 6.7.3

## Inputs

The example input is for the Constant-average acceleration method, ie -

* alfa = 0.5
* GAMA = 0.5
* DT = 0.1

For this question, I considered ONLY 8\*8 Linear Rectangular Element

### Mesh Inputs

|  |  |
| --- | --- |
| **Parameter** | **Value** |
| NX | 8 |
| NY | 8 |
| NPE (Linear rectangular element) | 4 |
| NDF | 1 |

### Domain Dimension

The domain is a square of side 2 unit.

X0 and Y0 are the coordinates of the 1st node of 1st element

|  |  |
| --- | --- |
| **Parameter** | **Value** |
| x\_length | 1 |
| y\_length | 1 |
| X0 | 0 |
| Y0 | 0 |

**Time Simulation Parameter**

|  |  |
| --- | --- |
| **Parameter** | **Value** |
| DT | 0.1 |
| NTime | 32 |

**Differential Equation Parameter**

ITEM = 1 (Parabolic Equation)

ITEM = 2 (Hyperbolic Equation)

Assumed equations for A11, A22, A00 are same -

A11 = A10 + A1xX + A1yY + A1uU + A1uxdUdX + A1uydUdY

Assumed equation for C and F are same -

C = C0 + CxX + CyY

|  |  |
| --- | --- |
| **Parameter** | **Value** |
| ITEM | 2 |
| PDECOEFF.A11 | [1 0 0 0 0 0] (Linear)  [1 0 0 0 0.2 0.2] (Non-Linear) |
| PDECOEFF.A22 | [1 0 0 0 0 0] (Linear)  [1 0 0 0 0.2 0.2] (Non-Linear) |
| PDECOEFF.A00 | [0 0 0 0 0 0] |
| PDECOEFF.C | [1 0 0] |
| PDECOEFF.F | [1 0 0] |

**Simulation Parameters**

NLS is not required for this assignment

|  |  |
| --- | --- |
| **Parameter** | **Value** |
| NONLIN | 1 |
| ITMAX | 5 |
| Epsilon | 0.001 |
| NLS | 5 |
| alfa | 0.5 |
| GAMA | 0.5 |

**Essential Boundary Conditions**

|  |  |
| --- | --- |
| **Parameter** | **Value** |
| NSPV | 17 |
| ISPV | [9 1; 18 1; 27 1; 36 1; 45 1; 54 1; 63 1; 72 1;81 1; 80 1; 79 1; 78 1; 77 1; 76 1; 75 1; 74 1; 73 1] |
| VSPV | zeros(NSPV,1) |

**Natural Boundary Condition**

|  |  |
| --- | --- |
| **Parameter** | **Value** |
| NSSV | 15 |
| ISSV | [1 1; 2 1; 3 1; 4 1; 5 1; 6 1; 7 1; 8 1; 10 1; 19 1; 28 1; 37 1; 46 1; 55 1; 64 1] |
| VSSV | zeros(NSSV,1) |

**Additional Input**

|  |  |
| --- | --- |
| **Parameter** | **Value** |
| Check\_Time | 0.05:0.05:1.25 |

### Results

|  |  |  |  |
| --- | --- | --- | --- |
| Time | CAM | LAM (DT = 0.1) | LAM (DT = 0.05) |
| 0.10 | 0.00250 | 0.00167 | 0.00292 |
| 0.20 | 0.01250 | 0.01167 | 0.01542 |
| 0.30 | 0.03250 | 0.03167 | 0.03792 |
| 0.40 | 0.06250 | 0.06167 | 0.07040 |
| 0.50 | 0.10250 | 0.10166 | 0.11293 |
| 0.60 | 0.15250 | 0.15168 | 0.16574 |
| 0.70 | 0.21250 | 0.21167 | 0.22690 |
| 0.80 | 0.28252 | 0.28124 | 0.29892 |
| 0.90 | 0.36239 | 0.36261 | 0.38962 |
| 1.00 | 0.45005 | 0.45652 | 0.48759 |
| 1.10 | 0.53780 | 0.54815 | 0.57007 |
| 1.20 | 0.61100 | 0.61605 | 0.63006 |
| 1.30 | 0.65500 | 0.65464 | 0.66192 |
| 1.40 | 0.66558 | 0.66580 | 0.66078 |
| 1.50 | 0.64920 | 0.64816 | 0.63590 |
| 1.60 | 0.61334 | 0.60793 | 0.59394 |
| 1.70 | 0.56235 | 0.55777 | 0.54241 |
| 1.80 | 0.50251 | 0.50230 | 0.48578 |
| 1.90 | 0.44190 | 0.43966 | 0.42599 |
| 2.00 | 0.38326 | 0.38715 | 0.36605 |
| 2.10 | 0.32430 | 0.31220 | 0.30689 |
| 2.20 | 0.26551 | 0.28407 | 0.25110 |
| 2.30 | 0.21050 | 0.17396 | 0.19591 |
| 2.40 | 0.16010 | 0.22499 | 0.14267 |
| 2.50 | 0.11311 | -0.00777 | 0.10136 |
| 2.60 | 0.07064 | 0.28332 | 0.06927 |
| 2.70 | 0.03435 | -0.34218 | 0.02892 |
| 2.80 | 0.00383 | 0.66530 | -0.01963 |
| 2.90 | 0.02043 | -1.18155 | -0.05526 |
| 3.00 | 0.03481 | 1.94539 | -0.06249 |
| 3.10 | 0.03388 | -3.50582 | -0.03580 |
| 3.20 | 0.01021 | 5.93986 | 0.02070 |