# TPLV102 - Transport of heat by convection in a Summarized

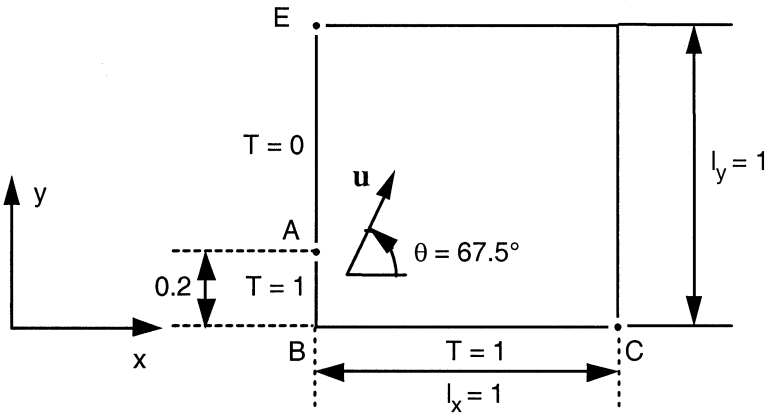
**parallelepiped:**

This functionality was developed in the code in order to be able to test the asymmetric matrixes.

The computation thermal steady is carried out on elements of type quadrangle with 4 nodes.

# 1 Problem of reference

## 1.1 Geometry




One considers the plane thermal problem of a square cavity (on side equal to 1) where heat is propagated:

by convection (i.e the particles constituting the medium of the cavity move at a velocity supposed $u$ here constant); the velocity $u$ is supposed to form an angle of with $67.5°$ the axis, $x$ by
conduction. Material properties

## 1.2 One

takes from where $\rho C_P = 1.$ $\lambda = 10^{-6}$

a diffusivity and $\alpha = \frac{\lambda}{\rho C_P} = 10^{-6}$

as one takes, $\|u\| = 1$ one has the Peclet number ( $p_e = \frac{\|u\|.L}{\alpha} = 10^6$ is $L$ the characteristic length, here). $L = 1.$ Boundary conditions

## 1.3 and loadings On

the segments and $AB$ , $BC$ one imposes a temperature On $T = 1.$

the segment, $AE$ one imposes a temperature On $T = 0.$

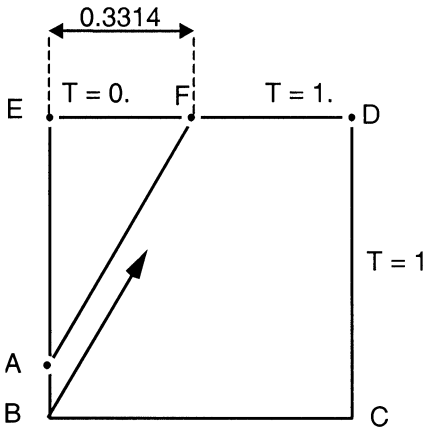
the 2 other sides, one has the condition by default, namely, one is with null flux. Reference solution

# 2 Method of calculating

## 2.1 used for the reference solution

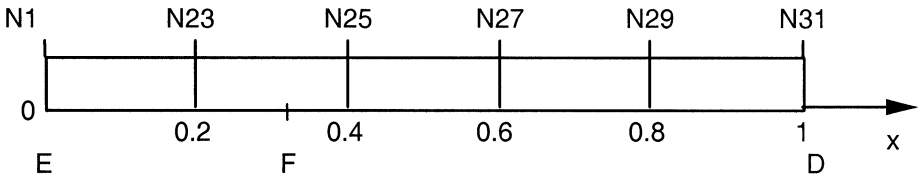
the reference solution is that recommended by Hughes and Brooks in their article quoted in bibliographical reference [bib1]. One

can take as exact solution the field of temperature of the border upstream project on the border downstream according to the direction velocity. Results




## 2.2 of reference One

tests the temperatures on the border between the points and $E$ . $D$ Uncertainty




## 2.3 on the analytical solution

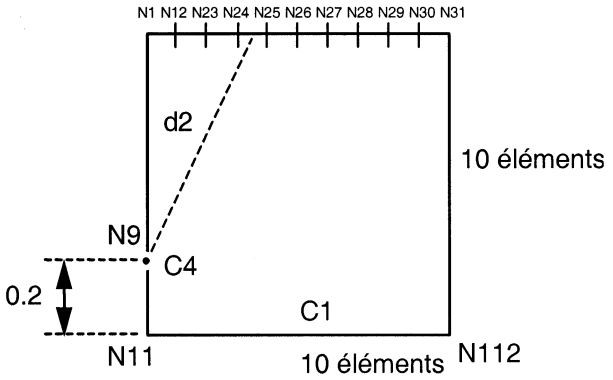
Solution. Bibliographical

## 2.4 references T.J.R.

- HUGHES, A. BROOKS “A multidimensional design with No crosswind diffusion” - T.J.R. HUGHES ED., Finite Element Methods for convection doninated flows, AMD vol. 34 (ASME, New York (1979)). Modelization

# 3 A Characteristic

## 3.1 of the modelization The modelization




is plane: the mesh consists of 100 elements QUAD4 squares of equal sizes, and 50 elements SEG2 on the borders . the temperature

of 0.0 is imposed on the GROUP_NO, the temperature *d2*
equal to 1.0 is imposed on the GROUP_NO and . Characteristics *C1* *C4*

## 3.2 of the mesh 50 SEG2, 100

QUAD4 Quantities tested

## 3.3 and Standard Identification

| results of Reference | | Reference | tolerance T | () ANALYTIQUE |
|---|---|---|---|---|
| $N31$ 1 $x=1.0$ | | . 1.3E-3 T | () | ANALYTIQUE |
| $N29$ 1 $x=0.8$ | | . 2.0E-4 T | () | ANALYTIQUE |
| $N27$ 1 $x=0.6$ | | . 3.0E-3 T | () | ANALYTIQUE |
| $N25$ 1 $x=0.4$ | | . 0.10 T () | ANALYTIQUE | |
| $N23$ 0 $x=0.2$ | | . 0.012 T ( | ) | ANALYTIQUE |
| $N1$ 0 $x=0.$ | . 1.0E-10 Summary | | | of |

# 4 the results Good asymmetric

matrix installation of for a plane thermal problem.