# Condition Limite en bas de Neumann discrétisée par un schéma centré

```
> restart : with(LinearAlgebra) :
> L := 20; H := 20; ndx := 3; ndy := 3;
```

$$L := 20$$
$$H := 20$$
$$ndx := 3$$
$$ndy := 3 \quad \textbf{(1.1)}$$

```
> Td := 30; Th := 10; Tg := 10; α := 0
```

$$Td := 30$$
$$Th := 10$$
$$Tg := 10$$
$$\alpha := 0 \quad \textbf{(1.2)}$$

```
> Δx := L/ndx; Δy := H/ndy; β := Δx/Δy
```

$$\Delta x := \frac{20}{3}$$
$$\Delta y := \frac{20}{3}$$
$$\beta := 1 \quad \textbf{(1.3)}$$

```
> i_max := ndx + 1;  j_max := ndy + 1;
```

$$i_{max} := 4$$
$$j_{max} := 4 \quad \textbf{(1.4)}$$

```
> N := (i_max - 2)·(j_max - 2) + i_max - 2;
```

$$N := 6 \quad \textbf{(1.5)}$$

**(1.6)**

```
> for j from 1 to j_max - 1 do T[1, j] := Tg end do;
```

$$T_{1,1} := 10$$
$$T_{1,2} := 10$$
$$T_{1,3} := 10 \quad \textbf{(1.7)}$$

```
> for j from 1 to  j_max - 1 do T[i_max, j] := Td end do;
```

$$T_{4,1} := 30$$
$$T_{4,2} := 30$$
$$T_{4,3} := 30 \quad \textbf{(1.8)}$$

```
> for i from 2 to i_max - 1 do T[i,  j_max] := Th end do;
```

$$T_{2,4} := 10$$
$$T_{3,4} := 10 \quad \textbf{(1.9)}$$

**(1.10)**

(1.11)

```
k := 1 :
 for i from 2 to i_max -1 do
    T[i, 0] := T[i, 2] - 2·α·Δy :
    Eq[k] := -2·(1 + β^2)·T[i, 1] + T[i + 1, 1] + T[i - 1, 1] + β^2·(T[i, 2]
   + T[i, 0]) = 0 :
    Temps[k] := T[i, 1] :
    k := k + 1 :
 end do:
 for j from 2 to j_max - 1 do
     for i from 2 to i_max -1 do
            Eq[k] := -2·(1 + β^2)·T[i, j] + T[i + 1, j] + T[i - 1, j] + β^2
  ·(T[i, j + 1] + T[i, j-1]) = 0 :
            Temps[k] := T[i, j] :
            k := k + 1 :
     end do
end do:
```

```
> for k from 1 to N do Eq[k] end do;
```

$$-4\,T_{2,1} + T_{3,1} + 10 + 2\,T_{2,2} = 0$$
$$-4\,T_{3,1} + 30 + T_{2,1} + 2\,T_{3,2} = 0$$
$$-4\,T_{2,2} + T_{3,2} + 10 + T_{2,3} + T_{2,1} = 0$$
$$-4\,T_{3,2} + 30 + T_{2,2} + T_{3,3} + T_{3,1} = 0$$
$$-4\,T_{2,3} + T_{3,3} + 20 + T_{2,2} = 0$$
$$-4\,T_{3,3} + 40 + T_{2,3} + T_{3,2} = 0 \qquad (1.12)$$

(1.13)

```
> N := k - 1;
```

$$N := 6 \qquad (1.14)$$

```
> Eqs := {seq(Eq[k], k = 1 ..N)};
```

$$Eqs := \{-4\,T_{2,1} + T_{3,1} + 10 + 2\,T_{2,2} = 0,\ -4\,T_{2,3} + T_{3,3} + 20 + T_{2,2} = 0,\ -4\,T_{3,1} + 30 + T_{2,1} + 2\,T_{3,2} = 0,\ -4\,T_{3,3} + 40 + T_{2,3} + T_{3,2} = 0,\ -4\,T_{2,2} + T_{3,2} + 10 + T_{2,3} + T_{2,1} = 0,\ -4\,T_{3,2} + 30 + T_{2,2} + T_{3,3} + T_{3,1} = 0\} \qquad (1.15)$$

```
> Tmps := [seq(Temps[k], k = 1 ..N)];
```

$$Tmps := [T_{2,1}, T_{3,1}, T_{2,2}, T_{3,2}, T_{2,3}, T_{3,3}] \qquad (1.16)$$

```
> SolT := solve(Eqs, Tmps);
```

$$SolT := \left[\left[T_{2,1} = \frac{1546}{99}, T_{3,1} = \frac{2194}{99}, T_{2,2} = \frac{500}{33}, T_{3,2} = \frac{710}{33}, T_{2,3} = \frac{1334}{99}, T_{3,3} = \frac{1856}{99}\right]\right] \qquad (1.17)$$

```
> Eqs := [seq(Eq[k], k = 1 ..N)];
```

$$Eqs := [-4\,T_{2,1} + T_{3,1} + 10 + 2\,T_{2,2} = 0,\ -4\,T_{3,1} + 30 + T_{2,1} + 2\,T_{3,2} = 0,\ -4\,T_{2,2} + T_{3,2} + 10 + T_{2,3} + T_{2,1} = 0,\ -4\,T_{3,2} + 30 + T_{2,2} + T_{3,3} + T_{3,1} = 0,\ -4\,T_{2,3} + T_{3,3}$$ (1.18)

$$+20+T_{2,2}=0,\ -4\,T_{3,3}+40+T_{2,3}+T_{3,2}=0\Big]$$

```
> M, R := GenerateMatrix(Eqs, Tmps)
```

$$M, R := \begin{bmatrix} -4 & 1 & 2 & 0 & 0 & 0 \\ 1 & -4 & 0 & 2 & 0 & 0 \\ 1 & 0 & -4 & 1 & 1 & 0 \\ 0 & 1 & 1 & -4 & 0 & 1 \\ 0 & 0 & 1 & 0 & -4 & 1 \\ 0 & 0 & 0 & 1 & 1 & -4 \end{bmatrix}, \begin{bmatrix} -10 \\ -30 \\ -10 \\ -30 \\ -20 \\ -40 \end{bmatrix} \tag{1.19}$$