Condition Limite de Neumann en bas et à droite discrétisées par un schéma centré

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

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

```
> Th := 10; Tg := 10; α[b] := 0; α[d] := 0; α[m] := 0.5·(α[b] + α[d])
```

$$Th := 10$$
$$Tg := 10$$
$$\alpha_b := 0$$
$$\alpha_d := 0$$
$$\alpha_m := 0. \quad (1.2)$$

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

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

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

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

```
> N := ( i_max − 2)·(j_max − 2) + (i_max − 2) + (j_max − 2) + 1;
```

$$N := 9 \quad (1.5)$$

(1.6)

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

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

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

$$T_{2,4} := 10$$
$$T_{3,4} := 10$$
$$T_{4,4} := 10 \quad (1.8)$$

```
> T[1, j_max] := 0.5·(Tg + Th);
```

$$T_{1,4} := 10.0 \quad (1.9)$$

(1.10)

(1.11)

```
k := 1 :
 for i from 2 to i_max do
     T[i, 0] := T[i, 2] − 2·α[b]·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:
 T[i_max + 1, 1] := T[i_max − 1, 1] + 2·α[m]·Δx :
 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:
      T[i_max + 1, j] := T[i_max − 1, j] + 2·α[d]·Δx :
      Eq[k] := − 2·(1 + β^2)·T[i_max, j] + T[i_max − 1, j] + T[i_max + 1, j] + β^2
   ·(T[i_max, j + 1] + T[i_max, j − 1]) = 0 :
      Temps[k] := T[i_max, j] :
      k := k + 1 :
end do:
```

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

$$-4\,T_{2,1}+T_{3,1}+10+2\,T_{2,2}=0$$

$$-4\,T_{3,1}+T_{4,1}+T_{2,1}+2\,T_{3,2}=0$$

$$-4\,T_{4,1}+2\,T_{3,1}+2\,T_{4,2}=0$$

$$-4\,T_{2,2}+T_{3,2}+10+T_{2,3}+T_{2,1}=0$$

$$-4\,T_{3,2}+T_{4,2}+T_{2,2}+T_{3,3}+T_{3,1}=0$$

$$-4\,T_{4,2}+2\,T_{3,2}+T_{4,3}+T_{4,1}=0$$

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

$$-4\,T_{3,3}+T_{4,3}+T_{2,3}+10+T_{3,2}=0$$

$$-4\,T_{4,3}+2\,T_{3,3}+10+T_{4,2}=0 \qquad \textbf{(1.12)}$$

(1.13)

```
> N := k − 1;
```

$$N := 9 \qquad \textbf{(1.14)}$$

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

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

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

$$Tmps := [T_{2,1}, T_{3,1}, T_{4,1}, T_{2,2}, T_{3,2}, T_{4,2}, T_{2,3}, T_{3,3}, T_{4,3}] \quad (1.16)$$

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

$$SolT := [[T_{2,1} = 10, T_{3,1} = 10, T_{4,1} = 10, T_{2,2} = 10, T_{3,2} = 10, T_{4,2} = 10, T_{2,3} = 10, T_{3,3} = 10, T_{4,3} = 10]] \quad (1.17)$$

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

$$Eqs := [-4\,T_{2,1} + T_{3,1} + 10 + 2\,T_{2,2} = 0, -4\,T_{3,1} + T_{4,1} + T_{2,1} + 2\,T_{3,2} = 0, -4\,T_{4,1} + 2\,T_{3,1} + 2\,T_{4,2} = 0, -4\,T_{2,2} + T_{3,2} + 10 + T_{2,3} + T_{2,1} = 0, -4\,T_{3,2} + T_{4,2} + T_{2,2} + T_{3,3} + T_{3,1} = 0, -4\,T_{4,2} + 2\,T_{3,2} + T_{4,3} + T_{4,1} = 0, -4\,T_{2,3} + T_{3,3} + 20 + T_{2,2} = 0, -4\,T_{3,3} + T_{4,3} + T_{2,3} + 10 + T_{3,2} = 0, -4\,T_{4,3} + 2\,T_{3,3} + 10 + T_{4,2} = 0] \quad (1.18)$$

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

$$M, R := \begin{bmatrix} -4 & 1 & 0 & 2 & 0 & 0 & 0 & 0 & 0 \\ 1 & -4 & 1 & 0 & 2 & 0 & 0 & 0 & 0 \\ 0 & 2 & -4 & 0 & 0 & 2 & 0 & 0 & 0 \\ 1 & 0 & 0 & -4 & 1 & 0 & 1 & 0 & 0 \\ 0 & 1 & 0 & 1 & -4 & 1 & 0 & 1 & 0 \\ 0 & 0 & 1 & 0 & 2 & -4 & 0 & 0 & 1 \\ 0 & 0 & 0 & 1 & 0 & 0 & -4 & 1 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 & 1 & -4 & 1 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 & 2 & -4 \end{bmatrix}, \begin{bmatrix} -10 \\ 0 \\ 0 \\ -10 \\ 0 \\ 0 \\ -20 \\ -10 \\ -10 \end{bmatrix} \quad (1.19)$$