Conditions Limites gauche et droite de Neumann discrétisée par un schéma centré

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

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

```
> Tb := 10; Th := 30; α[g] := 0; α[d] := 0
```

$$Tb := 10$$
$$Th := 30$$
$$\alpha_g := 0$$
$$\alpha_d := 0 \quad (1.2)$$

> $\Delta x := \frac{L}{ndx}$; $\Delta y := \frac{H}{ndy}$; $\beta := \frac{\Delta x}{\Delta y}$

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

> $i_{max} := ndx + 1$; $j_{max} := ndy + 1$;

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

> $N := (i_{max} - 2) \cdot (j_{max} - 2) + 2 \cdot (j_{max} - 2)$;

$$N := 8 \quad (1.5)$$

(1.6)

> **for** i **from** 1 **to** i_{max} **do** $T[i, 1] := Tb$ **end do**;

$$T_{1,1} := 10$$
$$T_{2,1} := 10$$
$$T_{3,1} := 10$$
$$T_{4,1} := 10 \quad (1.7)$$

> **for** i **from** 1 **to** i_{max} **do** $T[i, j_{max}] := Th$ **end do**;

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

```
k := 1 :
 T[0, 1] := T[2, 1] − 2·α[g]·Δx :
 T[0, j_max] := T[2, j_max] − 2·α[g]·Δx :
 T[i_max + 1, 1] := T[i_max − 1, 1] + 2·α[d]·Δx :
 T[i_max + 1, j_max] := T[i_max − 1, j_max] + 2·α[d]·Δx :
 for j from 2 to j_max − 1 do
      T[0, j] := T[2, j] − 2·α[g]·Δx :
      Eq[k] := T[2, j + 1] + T[2, j − 1] + T[0, j + 1] + T[0, j − 1] + 2·(5 − β^2)/(1 + β^2)
   ·(T[2, j] + T[0, j]) + 2·(5·β^2 − 1)/(1 + β^2)·(T[1, j + 1] + T[1, j − 1]) − 20·T[1, j]
   = 0 :
      Temps[k] := T[1, j] :
      k := k + 1 :
      for i from 2 to i_max -1 do
                    Eq[k] := T[i + 1, j + 1] + T[i + 1, j − 1] + T[i − 1, j + 1]
   + T[i − 1, j − 1] + 2·(5 − β^2)/(1 + β^2)·(T[i + 1, j] + T[i − 1, j]) + 2·(5·β^2 − 1)/(1 + β^2)·(T[i,
   j + 1] + T[i, j − 1]) − 20·T[i, j] = 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] := T[i_max + 1, j + 1] + T[i_max + 1, j − 1] + T[i_max − 1, j + 1]
   + T[i_max − 1, j − 1] + 2·(5 − β^2)/(1 + β^2)·(T[i_max + 1, j] + T[i_max − 1, j]) + 2
   ·(5·β^2 − 1)/(1 + β^2)·(T[i_max, j + 1] + T[i_max, j − 1]) − 20·T[i_max, j] = 0 :
      Temps[k] := T[i_max, j] :
      k := k + 1 :
end do:
```

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

$$2\,T_{2,3}+60+8\,T_{2,2}+4\,T_{1,3}-20\,T_{1,2}=0$$
$$T_{3,3}+60+T_{1,3}+4\,T_{3,2}+4\,T_{1,2}+4\,T_{2,3}-20\,T_{2,2}=0$$
$$T_{4,3}+60+T_{2,3}+4\,T_{4,2}+4\,T_{2,2}+4\,T_{3,3}-20\,T_{3,2}=0$$
$$2\,T_{3,3}+60+8\,T_{3,2}+4\,T_{4,3}-20\,T_{4,2}=0$$
$$180+2\,T_{2,2}+8\,T_{2,3}+4\,T_{1,2}-20\,T_{1,3}=0$$
$$180+T_{3,2}+T_{1,2}+4\,T_{3,3}+4\,T_{1,3}+4\,T_{2,2}-20\,T_{2,3}=0$$
$$180+T_{4,2}+T_{2,2}+4\,T_{4,3}+4\,T_{2,3}+4\,T_{3,2}-20\,T_{3,3}=0$$
$$180+2\,T_{3,2}+8\,T_{3,3}+4\,T_{4,2}-20\,T_{4,3}=0 \quad \textbf{(1.9)}$$

```
> N := k − 1;
```

(1.10)

$$N := 8 \quad \textbf{(1.10)}$$

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

$$Eqs := \{180 + 2\,T_{2,2} + 8\,T_{2,3} + 4\,T_{1,2} - 20\,T_{1,3} = 0, 180 + 2\,T_{3,2} + 8\,T_{3,3} + 4\,T_{4,2} - 20\,T_{4,3} = 0, 2\,T_{2,3} + 60 + 8\,T_{2,2} + 4\,T_{1,3} - 20\,T_{1,2} = 0, 2\,T_{3,3} + 60 + 8\,T_{3,2} + 4\,T_{4,3} - 20\,T_{4,2} = 0, 180 + T_{3,2} + T_{1,2} + 4\,T_{3,3} + 4\,T_{1,3} + 4\,T_{2,2} - 20\,T_{2,3} = 0, 180 + T_{4,2} + T_{2,2} + 4\,T_{4,3} + 4\,T_{2,3} + 4\,T_{3,2} - 20\,T_{3,3} = 0, T_{3,3} + 60 + T_{1,3} + 4\,T_{3,2} + 4\,T_{1,2} + 4\,T_{2,3} - 20\,T_{2,2} = 0, T_{4,3} + 60 + T_{2,3} + 4\,T_{4,2} + 4\,T_{2,2} + 4\,T_{3,3} - 20\,T_{3,2} = 0\} \quad \textbf{(1.11)}$$

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

$$Tmps := [T_{1,2}, T_{2,2}, T_{3,2}, T_{4,2}, T_{1,3}, T_{2,3}, T_{3,3}, T_{4,3}] \quad \textbf{(1.12)}$$

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

$$SolT := \left[\left[T_{1,2} = \frac{50}{3}, T_{2,2} = \frac{50}{3}, T_{3,2} = \frac{50}{3}, T_{4,2} = \frac{50}{3}, T_{1,3} = \frac{70}{3}, T_{2,3} = \frac{70}{3}, T_{3,3} = \frac{70}{3}, T_{4,3} = \frac{70}{3}\right]\right] \quad \textbf{(1.13)}$$

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

$$Eqs := [2\,T_{2,3} + 60 + 8\,T_{2,2} + 4\,T_{1,3} - 20\,T_{1,2} = 0, T_{3,3} + 60 + T_{1,3} + 4\,T_{3,2} + 4\,T_{1,2} + 4\,T_{2,3} - 20\,T_{2,2} = 0, T_{4,3} + 60 + T_{2,3} + 4\,T_{4,2} + 4\,T_{2,2} + 4\,T_{3,3} - 20\,T_{3,2} = 0, 2\,T_{3,3} + 60 + 8\,T_{3,2} + 4\,T_{4,3} - 20\,T_{4,2} = 0, 180 + 2\,T_{2,2} + 8\,T_{2,3} + 4\,T_{1,2} - 20\,T_{1,3} = 0, 180 + T_{3,2} + T_{1,2} + 4\,T_{3,3} + 4\,T_{1,3} + 4\,T_{2,2} - 20\,T_{2,3} = 0, 180 + T_{4,2} + T_{2,2} + 4\,T_{4,3} + 4\,T_{2,3} + 4\,T_{3,2} - 20\,T_{3,3} = 0, 180 + 2\,T_{3,2} + 8\,T_{3,3} + 4\,T_{4,2} - 20\,T_{4,3} = 0] \quad \textbf{(1.14)}$$

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

$$M, R := \begin{bmatrix} -20 & 8 & 0 & 0 & 4 & 2 & 0 & 0 \\ 4 & -20 & 4 & 0 & 1 & 4 & 1 & 0 \\ 0 & 4 & -20 & 4 & 0 & 1 & 4 & 1 \\ 0 & 0 & 8 & -20 & 0 & 0 & 2 & 4 \\ 4 & 2 & 0 & 0 & -20 & 8 & 0 & 0 \\ 1 & 4 & 1 & 0 & 4 & -20 & 4 & 0 \\ 0 & 1 & 4 & 1 & 0 & 4 & -20 & 4 \\ 0 & 0 & 2 & 4 & 0 & 0 & 8 & -20 \end{bmatrix}, \begin{bmatrix} -60 \\ -60 \\ -60 \\ -60 \\ -180 \\ -180 \\ -180 \\ -180 \end{bmatrix} \quad \textbf{(1.15)}$$