Exemplo 8.3

```
> with(LinearAlgebra) :
> psi := proc(i, x1, y1, x2, y2, x3, y3); local A, a, b, f, alpha, beta, gamma;
> a := x2 - x1;
> b := y3 - y2;
> A := abs((a*b)/2);
> alpha := 0; beta := 0; gamma := 0;
> if i = 1 then alpha := a*b; beta := -b; end if;
> if i = 2 then beta := b; gamma := -a; end if;
> if i = 3 then gamma := a; end if;
> return subs(x = x - x1, y = y - y1, piecewise(x <= a and x >= 0 and y >= 0 and y <= b and y
      <= b*x/a, 1/2*(alpha + beta*x + gamma*y)/A));
> end proc:
> a := .5; b := .5; f0 := 1;
```

$$a := 0.5$$
$$b := 0.5$$
$$f0 := 1 \tag{1}$$

```
> Ke := (1/(2*a*b))*Matrix(3, 3, [[b^2, -b^2, 0], [-b^2, a^2 + b^2, -a^2], [0, -a^2, a^2]])
```

$$Ke := \begin{bmatrix} 0.500000000000000000 & -0.500000000000000000 & 0. \\ -0.500000000000000000 & 1. & -0.500000000000000000 \\ 0. & -0.500000000000000000 & 0.500000000000000000 \end{bmatrix} \tag{2}$$

```
> fe := (f0*a*b/6)*Matrix(16, 1, [[1], [1], [1], [1], [1], [1]])
```

$$fe := \begin{bmatrix} \textit{16 x 1 Matrix} \\ \textit{Data Type: float}_8 \\ \textit{Storage: rectangular} \\ \textit{Order: Fortran\_order} \end{bmatrix} \tag{3}$$

```
> B := Matrix(16, 3, [[1, 2, 3], [5, 3, 2], [2, 4, 5], [3, 5, 6]])
```

$$B := \begin{bmatrix} \textit{16 x 3 Matrix} \\ \textit{Data Type: anything} \\ \textit{Storage: rectangular} \\ \textit{Order: Fortran\_order} \end{bmatrix} \tag{4}$$

```
> Rigidez := proc(E, N); local e, i, j, K;
> K := Matrix(N, N);
> for e from 1 to E do
> for i from 1 to 3 do
> for j from 1 to 3 do
> K[B[e, i], B[e, j]] := K[B[e, i], B[e, j]] + Ke[i, j];
> end do;
> end do;
```

```
> end do;
> return K :
> end proc:
> K := Rigidez(4, 6) :
> Carregamento :=proc(E, N); local e, i, F;
> F := Matrix(N, 1);
> for e from 1 to E do
> for i from 1 to 3 do
> F[B[e, i], 1] := F[B[e, i], 1] + fe[i, 1];
> end do;
> end do;
> return F;
> end proc:
> F := Carregamento(4, 6) :
> K11 := Matrix(3, 3) :
> K12 := Matrix(3, 3) :
> K21 := Matrix(3, 3) :
> K22 := Matrix(3, 3) :
> #Monta K^ij
> K11 := SubMatrix(K, [4..6], [4..6]) :
> K12 := SubMatrix(K, [4..6], [1..3]) :
> K21 := SubMatrix(K, [1..3], [4..6]) :
> K22 := SubMatrix(K, [1..3], [1..3]) :
> #Monta F^i
> F1 := SubMatrix(F, [4..6], [1]) :
> F2 := SubMatrix(F, [1..3], [1]) :
> #Monta U^i
> U1 := Matrix(3, 1) :
> U2 := Matrix(3, 1) :
> #Obtém U2
> U2 := MatrixMatrixMultiply(MatrixInverse(K22), Add(F2, MatrixMatrixMultiply(K21,
      U1)))
```

$$U2 := \begin{bmatrix} 0.3125000000010000001 \\ 0.229166666669999992 \\ 0.177083333335000009 \end{bmatrix} \quad (5)$$

```
> F1 := Add(MatrixMatrixMultiply(K11, U1), MatrixMatrixMultiply(K12, U2))
```

$$F1 := \begin{bmatrix} -0.114583333334999996 \\ -0.177083333335000009 \\ 0. \end{bmatrix} \quad (6)$$

```
>
```