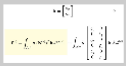
LECCION 4 - EJERCICIO 3 (15.3) v.2005

INICIO

```
Off[General::"spell1"]
Off[General::"spell"]
```

CALCULO VECTOR FUERZAS NODALES CONSISTENTES - PARA FUERZAS EN EL CUERPO

```
FnCFc =
```



```
;
```

```
Show[FnCFc, ImageSize → 300]
```

$$\mathbf{b} = \begin{bmatrix} b_x \\ b_y \end{bmatrix}$$

$$\mathbf{f}^{(e)} = \int_{\Omega^{(e)}} h\,(\mathbf{N}^{(e)})^T \mathbf{b}\, d\Omega^{(e)} = \int_{\Omega^{(e)}} h \begin{bmatrix} \zeta_1 & 0 \\ 0 & \zeta_1 \\ \zeta_2 & 0 \\ 0 & \zeta_2 \\ \zeta_3 & 0 \\ 0 & \zeta_3 \end{bmatrix} \mathbf{b}\, d\Omega^{(e)}$$

DEFINICION FUNCION ESPESOR EN EL ELEMENTO - A PARTIR ESPESORES EN NODOS

```
h[ζ1_, ζ2_, ζ3_] = h1 * ζ1 + h2 * ζ2 + h3 * ζ3;
```

DEFINICION MATRIZ FUNCIONES DE FORMA

```
Nf[ζ1_, ζ2_, ζ3_] = ( ζ1  0  ζ2  0  ζ3  0
                       0  ζ1  0  ζ2  0  ζ3 );
```

DEFINICION FUERZAS EN EL CUERPO

```
b[ζ1_, ζ2_, ζ3_] = ( 0
                     by1 * ζ1 + by2 * ζ2 + by3 * ζ3 );
```

CALCULO DEL INTEGRANDO DEL VECTOR FUERZA NODALES CONSISTENTES

```
Integrando[ζ1_, ζ2_, ζ3_] = h[ζ1, ζ2, ζ3] * Transpose[Nf[ζ1, ζ2, ζ3]].b[ζ1, ζ2, ζ3];
```

```
Integrando[ζ1, ζ2, ζ3] // MatrixForm
```

$$\begin{pmatrix} 0 \\ \zeta1\,(by1\,\zeta1 + by2\,\zeta2 + by3\,\zeta3) \\ (h1\,\zeta1 + h2\,\zeta2 + h3\,\zeta3) \\ 0 \\ \zeta2\,(by1\,\zeta1 + by2\,\zeta2 + by3\,\zeta3) \\ (h1\,\zeta1 + h2\,\zeta2 + h3\,\zeta3) \\ 0 \\ \zeta3\,(by1\,\zeta1 + by2\,\zeta2 + by3\,\zeta3) \\ (h1\,\zeta1 + h2\,\zeta2 + h3\,\zeta3) \end{pmatrix}$$

DEFINICION INTEGRAL-T

```
IntT = ∫_Ω(e) ζ1^i ζ2^j ζ3^k dΩ(e) = i! j! k! / (i + j + k + 2)!,  i ≥ 0, j ≥ 0, k ≥ 0 ;
```

```
Show[IntT, ImageSize → 300]
```

$$\frac{1}{2A}\int_{\Omega(e)} \zeta_1^i\,\zeta_2^j\,\zeta_3^k\,d\Omega^{(e)} = \frac{i!\,j!\,k!}{(i+j+k+2)!},\quad i\geq 0,\ j\geq 0,\ k\geq 0$$

```
IntegralT[i_, j_, k_] = 2 * A * Factorial[i] * Factorial[j] * Factorial[k] / Factorial[(i + j + k + 2)]
```

$$\frac{2\,A\,i!\,j!\,k!}{(2+i+j+k)!}$$

CALCULO FUERZA NODAL EQUIVALENTE EN NODO 1 - fy1

```
Ify1 = Integrando[ζ1, ζ2, ζ3][[2, 1]]
```

$$\zeta1\ (by1\,\zeta1 + by2\,\zeta2 + by3\,\zeta3)\ (h1\,\zeta1 + h2\,\zeta2 + h3\,\zeta3)$$

```
Ify1 = Expand[Ify1]
```

$$by1\,h1\,\zeta1^3 + by2\,h1\,\zeta1^2\,\zeta2 + by1\,h2\,\zeta1^2\,\zeta2 + by2\,h2\,\zeta1\,\zeta2^2 + by3\,h1\,\zeta1^2\,\zeta3 + by1\,h3\,\zeta1^2\,\zeta3 + by3\,h2\,\zeta1\,\zeta2\,\zeta3 + by2\,h3\,\zeta1\,\zeta2\,\zeta3 + by3\,h3\,\zeta1\,\zeta3^2$$

```
IntegralTRsFy1 = {ζ1^3 -> IntegralT[3, 0, 0], ζ1^2 ζ2 -> IntegralT[2, 1, 0], ζ1 ζ2^2 -> IntegralT[1, 2, 0],
   ζ1^2 ζ3 -> IntegralT[2, 0, 1], ζ1 ζ2 ζ3 -> IntegralT[1, 1, 1], ζ1 ζ3^2 -> IntegralT[1, 0, 2]}
```

$$\left\{\zeta1^3 \to \frac{A}{10},\ \zeta1^2\,\zeta2 \to \frac{A}{30},\ \zeta1\,\zeta2^2 \to \frac{A}{30},\ \zeta1^2\,\zeta3 \to \frac{A}{30},\ \zeta1\,\zeta2\,\zeta3 \to \frac{A}{60},\ \zeta1\,\zeta3^2 \to \frac{A}{30}\right\}$$

CALCULO VALOR DE LA FUERZA

```
fy1 = Ify1 /. IntegralTRsFy1
```

$$\frac{A\,by1\,h1}{10} + \frac{A\,by2\,h1}{30} + \frac{A\,by3\,h1}{30} + \frac{A\,by1\,h2}{30} + \frac{A\,by2\,h2}{30} + \frac{A\,by3\,h2}{60} + \frac{A\,by1\,h3}{30} + \frac{A\,by2\,h3}{60} + \frac{A\,by3\,h3}{30}$$

```
fy1 = Simplify[Factor[fy1]]
```

$$\frac{1}{60}\,A\,(2\,by1\,(3\,h1 + h2 + h3) + by2\,(2\,h1 + 2\,h2 + h3) + by3\,(2\,h1 + h2 + 2\,h3))$$

ok