LECCION 7 - EJERCICIO 1 (18.1) v.2005

INICIO

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

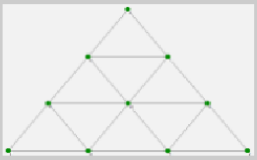
```
SetDirectory[NotebookDirectory[]]
```

```
C:\#0-Modulos-M30x_MeF-10\#M306-m6-a3a-sws\08-Funciones-forma
```

DEFINICION ELEMENTO TRIANGULAR REGULAR DE 10 NODOS

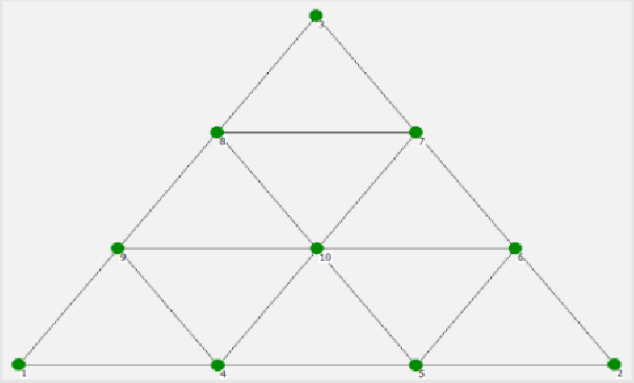
DEFINICION GRAFICA

```
Tri10 =
```



```
;
```

```
Tri10r = Show[Tri10, ImageSize → 300]
```



COORDENADAS TRIANGULARES NODOS

$$\text{Cnt} = \left\{\{1, 0, 0\}, \{0, 1, 0\}, \{0, 0, 1\}, \left\{\frac{2}{3}, \frac{1}{3}, 0\right\}, \left\{\frac{1}{3}, \frac{2}{3}, 0\right\}, \left\{0, \frac{2}{3}, \frac{1}{3}\right\}, \left\{0, \frac{1}{3}, \frac{2}{3}\right\}, \left\{\frac{1}{3}, 0, \frac{2}{3}\right\}, \left\{\frac{2}{3}, 0, \frac{1}{3}\right\}, \left\{\frac{1}{3}, \frac{1}{3}, \frac{1}{3}\right\}\right\};$$

```
NNodos = Dimensions[Cnt][[1]]
```

```
10
```

FUNCIONES DE FORMA - METODO PRODUCTO DE CURVAS

CURVA A CONSIDERAR

```
Cu = Table[0, {i, 9}];
```

LADOS

```
Cu[[1]] = ξ3; Cu[[2]] = ξ1; Cu[[3]] = ξ2;
```

MEDIANAS

```
Cu[[4]] = (ξ1 - 2 / 3); Cu[[5]] = (ξ1 - 1 / 3);
```

```
Cu[[6]] = (ξ2 - 2 / 3); Cu[[7]] = (ξ2 - 1 / 3);
```

```
Cu[[8]] = (ξ3 - 2 / 3); Cu[[9]] = (ξ3 - 1 / 3);
```

DEFINICION PRODUCTOS DE CURVAS EN CADA NODO

```
Nc = Table[0, {i, NNodos}];
```

Tipo 1 - ESQUINA

```
Nc[[1]] = Cu[[2]] * Cu[[4]] * Cu[[5]];
```

```
Nc[[2]] = Cu[[3]] * Cu[[6]] * Cu[[7]];
```

```
Nc[[3]] = Cu[[1]] * Cu[[8]] * Cu[[9]];
```

Tipo 2 - LADOS

```
Nc[[4]] = Cu[[2]] * Cu[[3]] * Cu[[5]];
```

```
Nc[[5]] = Cu[[2]] * Cu[[3]] * Cu[[7]];
```

```
Nc[[6]] = Cu[[1]] * Cu[[3]] * Cu[[7]];
```

```
Nc[[7]] = Cu[[1]] * Cu[[3]] * Cu[[9]];
```

```
Nc[[8]] = Cu[[1]] * Cu[[2]] * Cu[[9]];
```

```
Nc[[9]] = Cu[[1]] * Cu[[2]] * Cu[[5]];
```

Tipo 3- INTERIORES

```
Nc[[10]] = Cu[[1]] * Cu[[2]] * Cu[[3]];
```

OBTENCION FUNCIONES DE FORMA

```
Clear[Nf]
```

```
Nfp = Table[0, {i, NNodos}];
```

```
Nf = Table[0, {i, NNodos}];
```

```
Do[
  Nfp[[i]] = a * Nc[[i]];
  eq = 1 == Nfp[[i]] /. {ξ1 -> Cnt[[i, 1]], ξ2 -> Cnt[[i, 2]], ξ3 -> Cnt[[i, 3]]};
  as = a /. Solve[eq, a][[1]]; Print["Nodo ", i];
  Nf[[i]] = Simplify[Nfp[[i]] /. {a → as}],
  {i, NNodos}
 ];
```

```
Nodo 1
Nodo 2
Nodo 3
Nodo 4
Nodo 5
Nodo 6
Nodo 7
Nodo 8
Nodo 9
Nodo 10
```

```
MatrixForm[Nf]
```

$$\begin{pmatrix} \frac{1}{2}\xi 1\,(-2+3\,\xi 1)\,(-1+3\,\xi 1) \\ \frac{1}{2}\xi 2\,(-2+3\,\xi 2)\,(-1+3\,\xi 2) \\ \frac{1}{2}\xi 3\,(-2+3\,\xi 3)\,(-1+3\,\xi 3) \\ \frac{9}{2}\xi 1\,(-1+3\,\xi 1)\,\xi 2 \\ \frac{9}{2}\xi 1\,\xi 2\,(-1+3\,\xi 2) \\ \frac{9}{2}\xi 2\,(-1+3\,\xi 2)\,\xi 3 \\ \frac{9}{2}\xi 2\,\xi 3\,(-1+3\,\xi 3) \\ \frac{9}{2}\xi 1\,\xi 3\,(-1+3\,\xi 3) \\ \frac{9}{2}\xi 1\,(-1+3\,\xi 1)\,\xi 3 \\ 27\,\xi 1\,\xi 2\,\xi 3 \end{pmatrix}$$

■ COMPROBACION SUMA UNIDAD

$$\text{Suma} = \sum_{i=1}^{\text{NNodos}} \text{Nf}[[i]]$$

$$\frac{1}{2}\xi 1\,(-2+3\,\xi 1)\,(-1+3\,\xi 1)+\frac{9}{2}\xi 1\,(-1+3\,\xi 1)\,\xi 2+\frac{9}{2}\xi 1\,\xi 2\,(-1+3\,\xi 2)+\frac{1}{2}\xi 2\,(-2+3\,\xi 2)\,(-1+3\,\xi 2)+\frac{9}{2}\xi 1\,(-1+3\,\xi 1)\,\xi 3+27\,\xi 1\,\xi 2\,\xi 3+\frac{9}{2}\xi 2\,(-1+3\,\xi 2)\,\xi 3+\frac{9}{2}\xi 1\,\xi 3\,(-1+3\,\xi 3)+\frac{9}{2}\xi 2\,\xi 3\,(-1+3\,\xi 3)+\frac{1}{2}\xi 3\,(-2+3\,\xi 3)\,(-1+3\,\xi 3)$$

```
Simplify[Suma /. {ξ1 → 1 - ξ2 - ξ3}]
```

```
1
```

OK.

REPRESENTACION GRAFICA

Función Representación Gráfica Funciones de Forma

```
PlotTriangleShapeFunction[xytrig_, f_, Nsub_, aspect_] :=
  Module[{Ni, line3D = {}, poly3D = {}, zc1, zc2, zc3, xyf1, xyf2, xyf3, xc, yc, x1, x2, x3, y1, y2,
    y3, z1, z2, z3, iz1, iz2, iz3, d}, {{x1, y1, z1}, {x2, y2, z2}, {x3, y3, z3}} = Take[xytrig, 3];
   xc = {x1, x2, x3}; yc = {y1, y2, y3}; Ni = Nsub * 3;
   Do[Do[iz3 = Ni - iz1 - iz2; If[iz3 ≤ 0, Continue[]]; d = 0; If[Mod[iz1 + 2, 3] == 0 && Mod[iz2 - 1, 3] == 0,
      d = 1]; If[Mod[iz1 - 2, 3] == 0 && Mod[iz2 + 1, 3] == 0, d = -1]; If[d == 0, Continue[]];
     zc1 = N[{iz1 + d + d, iz2 - d, iz3 - d} / Ni]; zc2 = N[{iz1 - d, iz2 + d + d, iz3 - d} / Ni];
     zc3 = N[{iz1 - d, iz2 - d, iz3 + d + d} / Ni]; xyf1 = {xc.zc1, yc.zc1, f[zc1[[1]], zc1[[2]], zc1[[3]]]};
     xyf2 = {xc.zc2, yc.zc2, f[zc2[[1]], zc2[[2]], zc2[[3]]]}; xyf3 = {xc.zc3, yc.zc3,
       f[zc3[[1]], zc3[[2]], zc3[[3]]]}; AppendTo[poly3D, Polygon[{xyf1, xyf2, xyf3}]];
     AppendTo[line3D, Line[{xyf1, xyf2, xyf3, xyf1}]], {iz2, 1, Ni - iz1}], {iz1, 1, Ni}];
   Show[Graphics3D[RGBColor[1, 0, 0]], Graphics3D[poly3D], Graphics3D[Thickness[.002]],
    Graphics3D[line3D], Graphics3D[RGBColor[0, 0, 0]], Graphics3D[Thickness[.005]],
    Graphics3D[Line[xytrig]], PlotRange → All, BoxRatios → {1, 1, aspect}, Boxed → False]];
```

Representación Gráfica Funciones Forma Elemento.

```
Ng = Table[0, {i, NNodos}];
```

```
xyc1 = {0, 0, 0}; xyc2 = {3, 0, 0}; xyc3 = {Sqrt[3], 3 / 2, 0}; xytrig = N[{xyc1, xyc2, xyc3, xyc1}];
```

Control de Cuadricula

```
Nsub = 15;
```

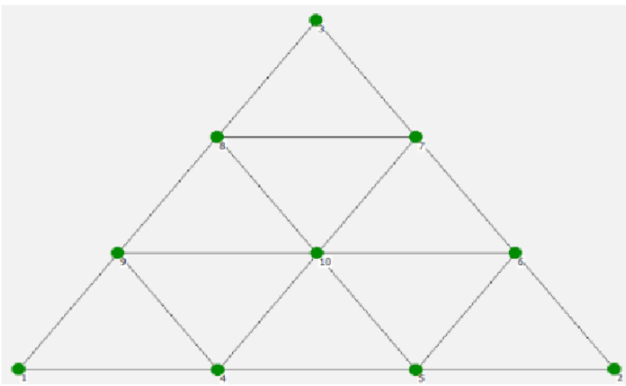
```
Do[
  fi[ξ1_, ξ2_, ξ3_] = Nf[[i]];
  Ng[[i]] = PlotTriangleShapeFunction[xytrig, fi, Nsub, 1 / 2],
  {i, NNodos}
 ];
```

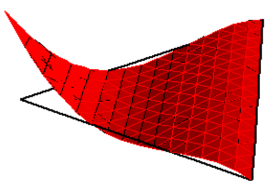
RESULTADOS INTERACTIVOS

```
Manipulate[{Tri10r, Ng[[n]], Nf[[n]]}, {n, 1, Dimensions[Nf][[1]], 1}, {n, Range[Dimensions[Nf][[1]]]},
 FrameLabel → {"FUNCION DE FORMA EN NODO n - TRIANGULO REGULAR 10 NODOS"}, SaveDefinitions → True]
```

n

n 1

{  ,



$$, \frac{1}{2}\,\xi 1\,(-2+3\,\xi 1)\,(-1+3\,\xi 1)\}$$

FUNCION DE FORMA EN NODO n – TRIANGULO REGULAR 10 NODOS