

LECCION 7 - EJERCICIO 3 (18.3) v.2005

■ INICIO

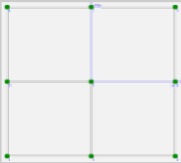
```
Off [General::"spell1"]  
Off [General::"spell"]
```

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

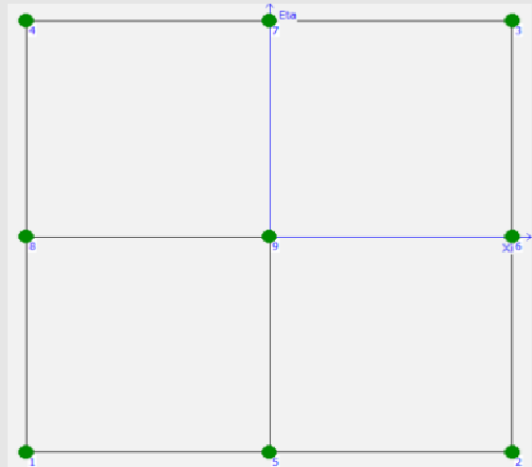
```
C:\#0-Modulos-M30x_MeF-10\#M306-m6-a3a-sws\08-Funciones-forma
```

■ DEFINICION ELEMENTO CUADRILATERO REGULAR DE 9 NODOS

□ DEFINICION GRAFICA

CuaR9 = ;

```
CuaR9r = Show [CuaR9, ImageSize -> 250]
```



□ COORDENADAS NATURALES NODOS

```
Cn = {{-1, -1}, {1, -1}, {1, 1}, {-1, 1}, {0, -1}, {1, 0}, {0, 1}, {-1, 0}, {0, 0}};
```

```
NNodos = Dimensions [Cn] [[1]]
```

```
9
```

3. FUNCIONES DE FORMA - METODO PRODUCTO DE CURVAS

■ CURVAS A CONSIDERAR

$$Cu = \text{Table}[0, \{i, 6\}];$$

□ LADOS

$$Cu[[1]] = (\eta + 1); \quad Cu[[2]] = (\xi - 1); \quad Cu[[3]] = (\eta - 1); \quad Cu[[4]] = (\xi + 1);$$

□ MEDIANAS

$$Cu[[5]] = \eta; \quad Cu[[6]] = \xi;$$

■ DEFINICION PRODUCTOS DE CURVAS EN CADA NODO

$$Nc = \text{Table}[0, \{i, \text{NNodos}\}];$$

□ Tipo 1 - ESQUINA

$$Nc[[4]] = Cu[[1]] * Cu[[2]] * Cu[[5]] * Cu[[6]]$$

$$\eta (1 + \eta) (-1 + \xi) \xi$$

$$Nc[[3]] = Cu[[1]] * Cu[[4]] * Cu[[5]] * Cu[[6]]$$

$$\eta (1 + \eta) \xi (1 + \xi)$$

$$Nc[[2]] = Cu[[3]] * Cu[[4]] * Cu[[5]] * Cu[[6]]$$

$$(-1 + \eta) \eta \xi (1 + \xi)$$

$$Nc[[1]] = Cu[[2]] * Cu[[3]] * Cu[[5]] * Cu[[6]]$$

$$(-1 + \eta) \eta (-1 + \xi) \xi$$

□ Tipo 2 - LADOS

$$Nc[[5]] = Cu[[2]] * Cu[[3]] * Cu[[4]] * Cu[[5]]$$

$$(-1 + \eta) \eta (-1 + \xi) (1 + \xi)$$

$$Nc[[6]] = Cu[[1]] * Cu[[3]] * Cu[[4]] * Cu[[6]]$$

$$(-1 + \eta) (1 + \eta) \xi (1 + \xi)$$

$$Nc[[7]] = Cu[[1]] * Cu[[2]] * Cu[[4]] * Cu[[5]]$$

$$\eta (1 + \eta) (-1 + \xi) (1 + \xi)$$

```
Nc[[8]] = Cu[[1]] * Cu[[2]] * Cu[[3]] * Cu[[6]]
```

$$(-1 + \eta) (1 + \eta) (-1 + \xi) \xi$$

▣ **Tipo 3 - INTERIOR**

```
Nc[[9]] = Cu[[1]] * Cu[[2]] * Cu[[3]] * Cu[[4]]
```

$$(-1 + \eta) (1 + \eta) (-1 + \xi) (1 + \xi)$$

■ **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]] /. {ξ -> Cn[[i, 1]], η -> Cn[[i, 2]]};
  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

```
MatrixForm[Nf]
```

$$\begin{pmatrix} \frac{1}{4} (-1 + \eta) \eta (-1 + \xi) \xi \\ \frac{1}{4} (-1 + \eta) \eta \xi (1 + \xi) \\ \frac{1}{4} \eta (1 + \eta) \xi (1 + \xi) \\ \frac{1}{4} \eta (1 + \eta) (-1 + \xi) \xi \\ -\frac{1}{2} (-1 + \eta) \eta (-1 + \xi) (1 + \xi) \\ -\frac{1}{2} (-1 + \eta) (1 + \eta) \xi (1 + \xi) \\ -\frac{1}{2} \eta (1 + \eta) (-1 + \xi) (1 + \xi) \\ -\frac{1}{2} (-1 + \eta) (1 + \eta) (-1 + \xi) \xi \\ (-1 + \eta) (1 + \eta) (-1 + \xi) (1 + \xi) \end{pmatrix}$$

■ COMPROBACION SUMA UNIDAD

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

$$\begin{aligned} & \frac{1}{4} (-1+\eta) \eta (-1+\xi) \xi - \frac{1}{2} (-1+\eta) (1+\eta) (-1+\xi) \xi + \frac{1}{4} \eta (1+\eta) (-1+\xi) \xi - \\ & \frac{1}{2} (-1+\eta) \eta (-1+\xi) (1+\xi) + (-1+\eta) (1+\eta) (-1+\xi) (1+\xi) - \frac{1}{2} \eta (1+\eta) (-1+\xi) (1+\xi) + \\ & \frac{1}{4} (-1+\eta) \eta \xi (1+\xi) - \frac{1}{2} (-1+\eta) (1+\eta) \xi (1+\xi) + \frac{1}{4} \eta (1+\eta) \xi (1+\xi) \end{aligned}$$

Simplify[%]

1

OK.

■ REPRESENTACION GRAFICA

- Función Representación Gráfica Funciones de Forma
- Representación Gráfica Funciones Forma Elemento.

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

```
xyc1 = {0, 0, 0}; xyc2 = {3, 0, 0}; xyc3 = {3, 3, 0};
xyc4 = {0, 3, 0}; xyquad = N[{xyc1, xyc2, xyc3, xyc4, xyc1}];
```

Control de Cuadrícula

```
Nsub = 10;
```

```
Do[
  fi[ξ_, η_] = Nf[[i]];
  Ng[[i]] = PlotQuadrilateralShapeFunction[xyquad, fi, Nsub, 1/2],
  {i, NNodos}
];
```

4. RESULTADOS INTERACTIVOS -

```
Manipulate[{CuaR9r, Ng[[n]], Nf[[n]]}, {n, 1, Dimensions[Nf][[1]], 1}, {n, Range[Dimensions[Nf][[1]]],  
FrameLabel -> {"FUNCION DE FORMA EN NODO n - CUADRILATERO REGULAR 9 NODOS"}, SaveDefinitions -> True]
```

