LECCION 7 - EJERCICIO 6 (18.6) v.2005

INICIO

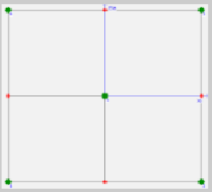
```
Off[General::"spell1"]
Off[General::"spell"]
```

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

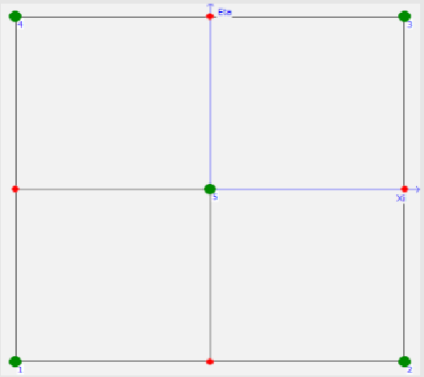
```
C:\#0-Modulos-M30x_MeF-10\#M306-m6-a3a-sws\08-Funciones-forma
```

DEFINICION ELEMENTO CUADRILATERO DE TRANSICION DE 5 NODOS

DEFINICION GRAFICA

CuaT5 =  ;

```
CuaT5r = Show[CuaT5, ImageSize → 200]
```



COORDENADAS NATURALES NODOS

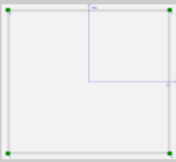
```
Cn = {{-1, -1}, {1, -1}, {1, 1}, {-1, 1}, {0, 0}};
```

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

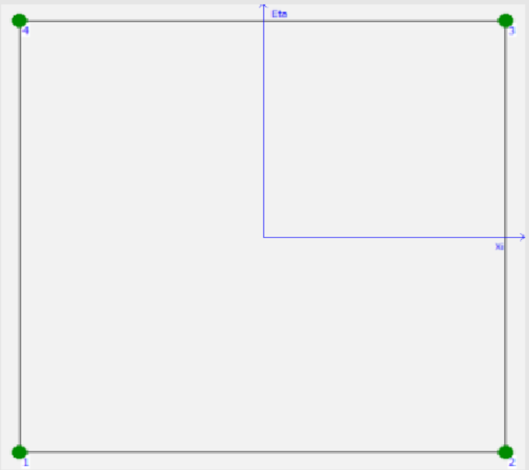
```
5
```

■ ELEMENTOS COMPLETOS NECESARIOS

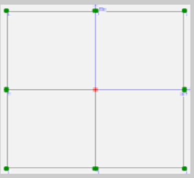
□ REGULAR DE 4 NODOS

CuaR4 =  ;

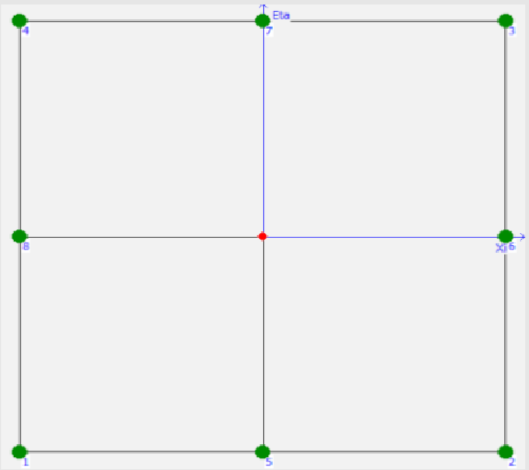
```
CuaR4r = Show[CuaR4, ImageSize → 250]
```



□ SERENDIPITO DE 8 NODOS - 2 DIVISIONES POR LADO

CuaS8 =  ;

```
CuaS8r = Show[CuaS8, ImageSize → 250]
```



FUNCIONES DE FORMA - METODO PRODUCTO DE CURVAS

Curvas a Considerar

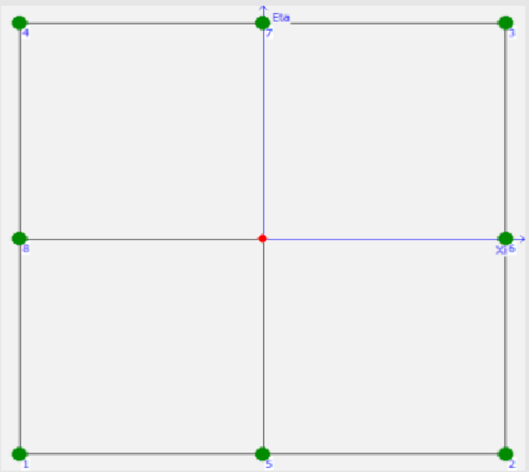
LADOS - CUADRILATERO REGULAR DE 4 NODOS

```
CuCR04N = Table[0, {i, 4}];
```

```
CuCR04N[[1]] = (η + 1); CuCR04N[[2]] = (ξ - 1); CuCR04N[[3]] = (η - 1); CuCR04N[[4]] = (ξ + 1);
```

LADOS Y MEDIANAS - CUADRILATERO SERENDIPITO DE 8 NODOS

```
Show[CuaS8, ImageSize → 250]
```




```
CuCS8N = Table[0, {i, 6 }];
```

```
CuCS8N[[1]] = (η + 1);
CuCS8N[[2]] = (ξ - 1);
CuCS8N[[3]] = (η - 1);
CuCS8N[[4]] = (ξ + 1);
```

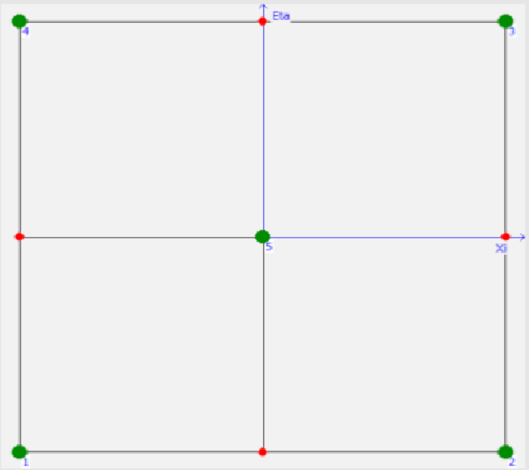
```
CuCS8N[[5]] = (ξ);
```

```
CuCS8N[[6]] = (η);
```

Definición Productos de Curvas en cada Nodo - # - NODOS NO ESQUINA

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

```
Show[CuaT5, ImageSize → 250]
```



Tipo 1 - INTERIOR

```
Nc[[5]] = CuCS8N[[1]] * CuCS8N[[2]] * CuCS8N[[3]] * CuCS8N[[4]];
```

Obtención Funciones de Forma - NODOS NO ESQUINA

```
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, 5, NNodos}
 ];
```

Nodo 5

```
MatrixForm[Nf]
```

$$\begin{pmatrix} 0 \\ 0 \\ 0 \\ 0 \\ (-1+\eta)\ (1+\eta)\ (-1+\xi)\ (1+\xi) \end{pmatrix}$$

Obtención Funciones de Forma - NODOS ESQUINA

Utilizamos las Funciones de Forma del Cuadrilatero de 4 Nodos.

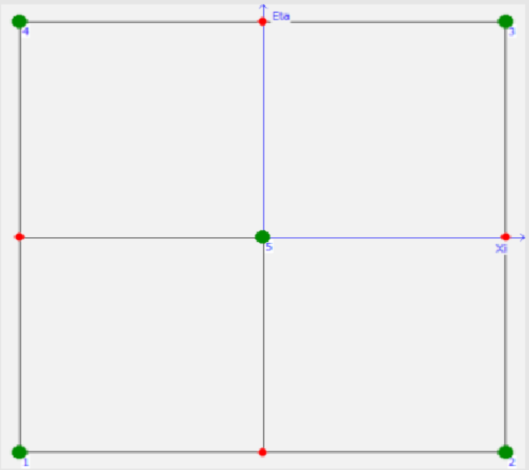
$$\text{NfCR4} = \left\{\frac{1}{4}\ (-1+\eta)\ (-1+\xi),\ -\frac{1}{4}\ (-1+\eta)\ (1+\xi),\ \frac{1}{4}\ (1+\eta)\ (1+\xi),\ -\frac{1}{4}\ (1+\eta)\ (-1+\xi)\right\};$$

NODO 1 - Desarrollo -

```
Clear[a5];
```

```
Nf[[1]] = NfCR4[[1]] + a5 * Nf[[5]];
```

```
Show[CuaT5, ImageSize → 250]
```




```
eq = 0 == Nf[[1]] /. {ξ -> Cn[[5]][[1]], η -> Cn[[5]][[2]]}
a5s = a5 /. Solve[eq, a5][[1]]
```

$$0 == \frac{1}{4} + a5$$

$$-\frac{1}{4}$$

```
Nf[[1]] = Simplify[Nf[[1]] /. {a5 → a5s}];
```

```
Nf[[1]]
```

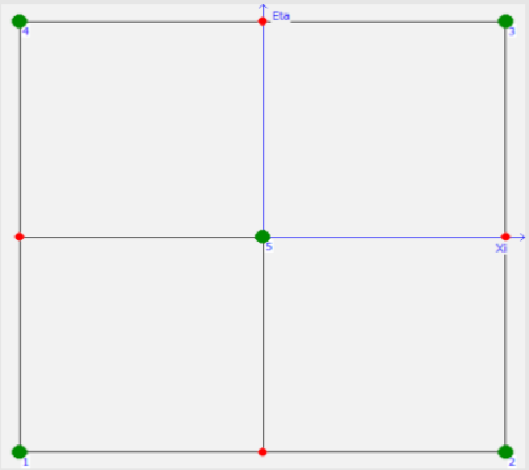
$$-\frac{1}{4}\,(-1+\eta)\,(-1+\xi)\,(\eta+\xi+\eta\,\xi)$$

NODO 2 - Desarrollo -

```
Clear[a5];
```

```
Nf[[2]] = NfCR4[[2]] + a5 * Nf[[5]];
```

```
Show[CuaT5, ImageSize → 250]
```




```
eq = 0 == Nf[[2]] /. {ξ -> Cn[[5]][[1]], η -> Cn[[5]][[2]]}
a5s = a5 /. Solve[eq, a5][[1]]
```

$0 == \frac{1}{4} + a5$

$-\frac{1}{4}$

```
Nf[[2]] = Simplify[Nf[[2]] /. {a5 → a5s}]
```

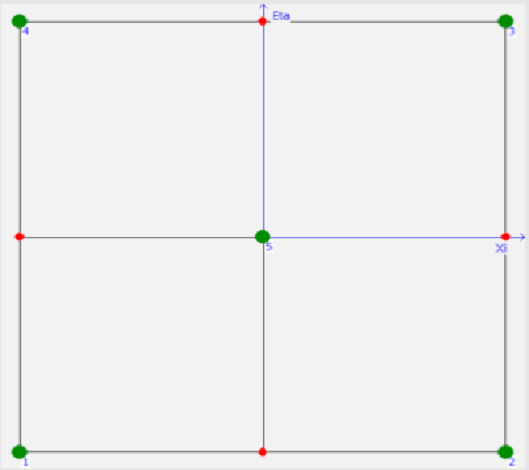
$-\frac{1}{4}(-1+\eta)(1+\xi)(\eta(-1+\xi)+\xi)$

NODO 3 - Desarrollo -

```
Clear[a5];
```

```
Nf[[3]] = NfCR4[[3]] + a5 * Nf[[5]];
```

```
Show[CuaT5, ImageSize → 250]
```



```
eq = 0 == Nf[[3]] /. {ξ -> Cn[[5]][[1]], η -> Cn[[5]][[2]]}
a5s = a5 /. Solve[eq, a5][[1]]
```

$0 == \frac{1}{4} + a5$

$-\frac{1}{4}$

```
Nf[[3]] = Simplify[Nf[[3]] /. {a5 → a5s}]
```

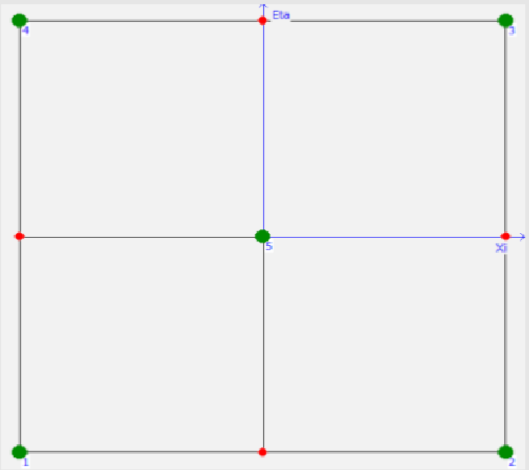
$\frac{1}{4}\left(\eta + \eta^2 + \xi + \eta\,\xi + \xi^2 - \eta^2\,\xi^2\right)$

NODO 4 - Desarrollo -

```
Clear[a5];
```

```
Nf[[4]] = NfCR4[[4]] + a5 * Nf[[5]];
```

```
Show[CuaT5, ImageSize → 250]
```




```
eq = 0 == Nf[[4]] /. {ξ -> Cn[[5]][[1]], η -> Cn[[5]][[2]]}
a5s = a5 /. Solve[eq, a5][[1]]
```

$0 == \frac{1}{4} + a5$

$-\frac{1}{4}$

```
Nf[[4]] = Simplify[Nf[[4]] /. {a5 → a5s}]
```

$-\frac{1}{4}(1+\eta)(-1+\xi)(\eta - \xi + \eta\,\xi)$

Funciones de Forma de todos los Nodos.

```
MatrixForm[Nf]
```

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

Comprobación Suma Unidad -

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

$$(-1+\eta)(1+\eta)(-1+\xi)(1+\xi)-\frac{1}{4}(-1+\eta)(1+\xi)(\eta(-1+\xi)+\xi)-\frac{1}{4}(1+\eta)(-1+\xi)(\eta-\xi+\eta\,\xi)-\frac{1}{4}(-1+\eta)(-1+\xi)(\eta+\xi+\eta\,\xi)+\frac{1}{4}\left(\eta+\eta^2+\xi+\eta\,\xi+\xi^2-\eta^2\,\xi^2\right)$$

```
Simplify[%]
```

1

OK.

Proceso para comprobar Valor Funciones de Forman en Nodos - en caso de Error

```
Do[
  Print["NODO ", j];
  Do[
   Print[i, "   ", Simplify[Nf[[j]] /. {ξ -> Cn[[i, 1]], η -> Cn[[i, 2]]}]],
   {i, NNodos}
    ],
  {j, NNodos}
 ];
```

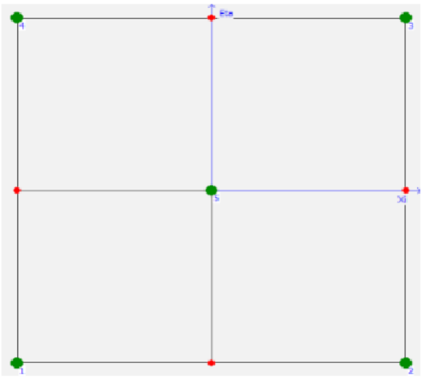
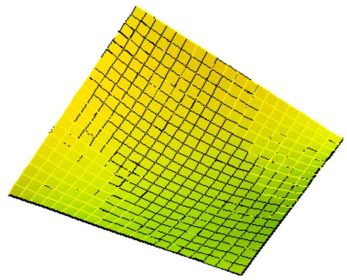
Representación Gráfica.

RESULTADOS INTERACTIVOS

```
Manipulate[{CuaT5r, Ng[[n]], Nf[[n]]}, {n, 1, Dimensions[Nf][[1]], 1}, {n, Range[Dimensions[Nf][[1]]]},
 FrameLabel → {"FUNCION DE FORMA EN NODO n - CUADRILATERO TRANSICION 5 NODOS"},
 SaveDefinitions → True]
```

n

n 1 2 3 4 5

{  ,  , $-\frac{1}{4}(1+\eta)(-1+\xi)(\eta-\xi+\eta\,\xi)$ }

FUNCION DE FORMA EN NODO n – CUADRILATERO TRANSICION 5 NODOS