

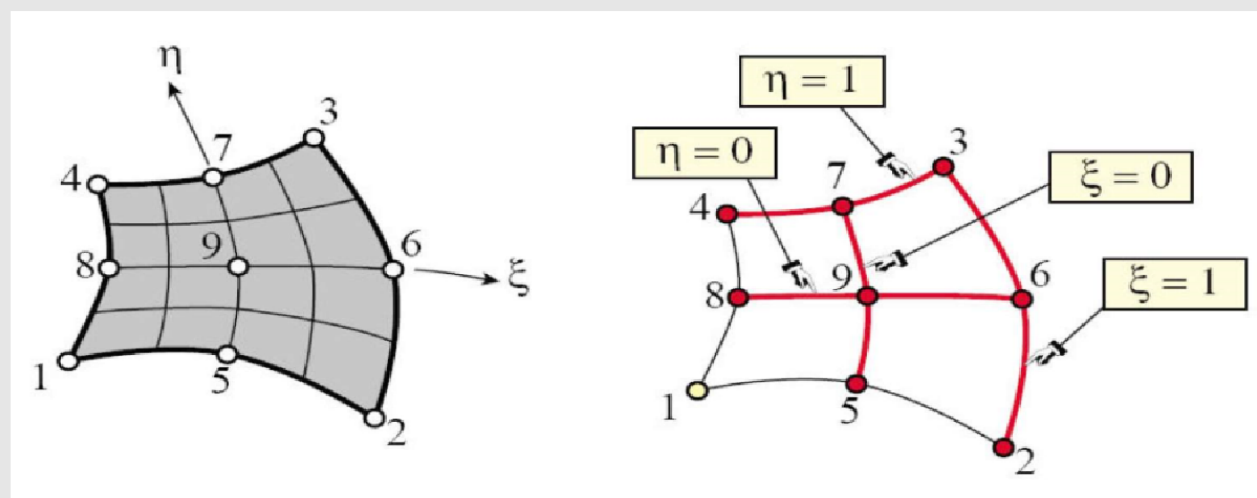
■ INICIO

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

■ DEFINICION ELEMENTO CUADRILATERO REGULAR DE 9 NODOS

CuaR9 = 

```
Show[CuaR9, ImageSize -> 600]
```



■ OBTENCION FUNCION FORMA NODO 1 - METODO PRODUCTO DE CURVAS - ALTERNATIVO

□ CURVAS A CONSIDERAR

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

□ LADOS - 2-3 - 3-4

```
Cu[[1]] = xi - 1; Cu[[2]] = eta - 1;
```

□ DIAGONALES - 5-8 - 2-9-4

```
Cu[[3]] = xi + eta + 1; Cu[[4]] = xi + eta;
```

□ DEFINICION PRODUCTO CURVAS

```
N1p[xi_, eta_] = c Cu[[1]] Cu[[2]] Cu[[3]] Cu[[4]];
```

□ CONDICION VALOR 1 EN NODO 1

```
eq = 1 == N1p[-1, -1]
```

```
1 == 8 c
```

▣ CALCULO CONSTANTE

```
cs = c /. Solve[eq, c][[1]]

1
8
```

▣ DEFINICION FUNCION DE FORMA

```
N1s[ξ_, η_] = N1p[ξ, η] /. {c → cs}

1
8 (-1 + η) (-1 + ξ) (η + ξ) (1 + η + ξ)
```

■ REPRESENTACION GRAFICA

▣ Función Representación Gráfica Funciones de Forma

```
PlotQuadrilateralShapeFunction[xyquad_, f_, Nsub_, aspect_] :=
Module[{Ne, Nev, line3D = {}, poly3D = {}, xyf1, xyf2, xyf3, i, j, n,
  ixi, ieta, xi, eta, x1, x2, x3, x4, y1, y2, y3, y4, z1, z2, z3, z4, xc, yc},
  {{x1, y1, z1}, {x2, y2, z2}, {x3, y3, z3}, {x4, y4, z4}} = Take[xyquad, 4];
  xc = {x1, x2, x3, x4}; yc = {y1, y2, y3, y4};
  Ne[xi_, eta_] := N[{(1 - xi) * (1 - eta), (1 + xi) * (1 - eta), (1 - xi) * (1 + eta)} / 4];
  n = Nsub; Do[Do[ixi = (2 * i - n - 1) / n; ieta = (2 * j - n - 1) / n;
    {xi, eta} = N[{ixi - 1 / n, ieta - 1 / n}]; Nev = Ne[xi, eta];
    xyf1 = {xc.Nev, yc.Nev, f[xi, eta]}; {xi, eta} = N[{ixi + 1 / n, ieta - 1 / n}]; Nev = Ne[xi, eta];
    xyf2 = {xc.Nev, yc.Nev, f[xi, eta]}; {xi, eta} = N[{ixi + 1 / n, ieta + 1 / n}]; Nev = Ne[xi, eta];
    xyf3 = {xc.Nev, yc.Nev, f[xi, eta]}; {xi, eta} = N[{ixi - 1 / n, ieta + 1 / n}]; Nev = Ne[xi, eta];
    xyf4 = {xc.Nev, yc.Nev, f[xi, eta]}; AppendTo[poly3D, Polygon[{xyf1, xyf2, xyf3, xyf4}]];
    AppendTo[line3D, Line[{xyf1, xyf2, xyf3, xyf4, xyf1}], {i, 1, Nsub}], {j, 1, Nsub}];
  Show[Graphics3D[RGBColor[1, 1, 0]], Graphics3D[poly3D], Graphics3D[Thickness[.002]],
    Graphics3D[line3D], Graphics3D[RGBColor[0, 0, 0]], Graphics3D[Thickness[.005]],
    Graphics3D[Line[xyquad]], PlotRange → All, BoxRatios → {1, 1, aspect}, Boxed → False];
```

▣ Representación Gráfica Funcion Forma

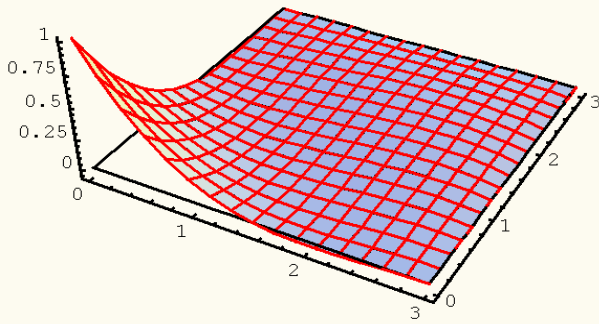
```
xyqc1 = {0, 0, 0}; xyqc2 = {3, 0, 0}; xyqc3 = {3, 3, 0}; xyqc4 = {0, 3, 0};
xyquad = N[{xyqc1, xyqc2, xyqc3, xyqc4, xyqc1}]; Nsub = 16;

f[ξ_, η_] = N1s[ξ, η]

1
8 (-1 + η) (-1 + ξ) (η + ξ) (1 + η + ξ)

N1 = PlotQuadrilateralShapeFunction[xyquad, f, Nsub, 1 / 2];
```

```
Show[N1, Axes -> True, AspectRatio -> Automatic];
```



■ COMPROBACION COMPATIBILIDAD - LADO 1-2

□ CONDICION EN LADO

```
{η -> -1};
```

□ GRADO FUNCION DE FORMA EN LADO 1-2 -> CUBICO

```
Expand[N1s[ξ, η] /. {η -> -1}]
```

$$-\frac{\xi}{4} + \frac{\xi^2}{2} - \frac{\xi^3}{4}$$

UNA FUNCION CUBICA SE DEFINE POR 4 NODOS - EN AL LADO 1-2 SOLO HAY 3 ---> NO SE CUMPLE LA CONDICION DE COMPATIBILIDAD