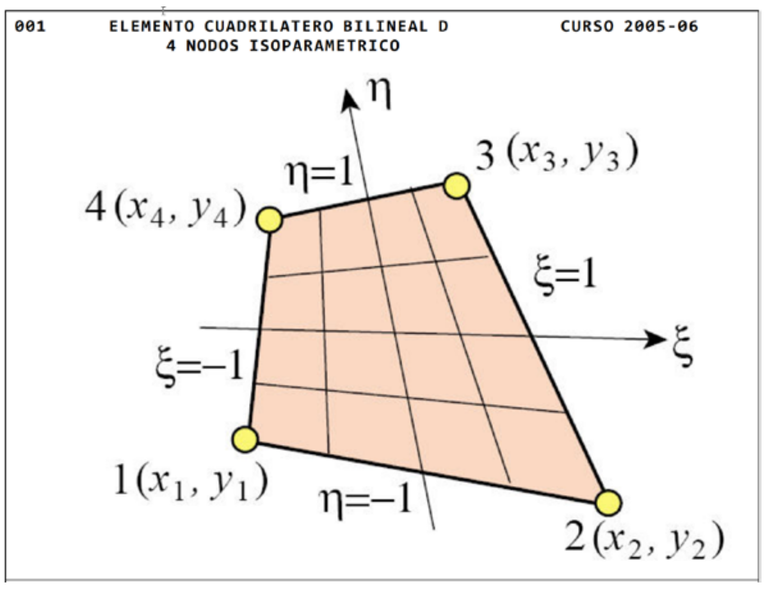
Esta ACTIVIDAD DE CLASE deberá realizarse descargando los documentos *NB* incompletos correspondientes a estos ejercicios de clase. Deberás seleccionar en el siguiente panel el enlace correspondiente al número que se te ha asignado en la cuenta del material personalizado de la actividad ***m1-a1a***.

18-CP-C8-Mathematica-C

EJERCICIO 0
ELEMENTO CUADRILATERO REGULAR DE 4 NODOS



EJERCICIO 1
ELEMENTO CUADRILATERO DE TRANSICION DE 5 NODOS

001 EJERCICIO 1 CURSO 2005-06

EXERCISE 23.1

[C:15] Figures E23.1–2 show the *Mathematica* implementation of the stiffness modules for the 5-node, "bilinear+bubble" iso-P quadrilateral of Figure E18.3. Module `Quad5IsoPMembraneStiffness` returns the 10 × 10 stiffness matrix whereas module `Quad5IsoPShapeFunDer` returns shape function values and Cartesian derivatives. (The Gauss quadrature module is reused.) Both modules follow the style of the 4-node quadrilateral implementation listed in Figures 23.4–5. The only differences in argument lists is that `ncoor` has five node coordinates: `{{x1,y1},{x2,y2},{x3,y3},{x4,y4},{x5,y5}}`, and that a variable plate thickness in `fprop` (one of the 3 possible formats) is specified as `{h1,h2,h3,h4,h5}`.

```
Quad5IsoPMembraneStiffness[ncoor_,mprop_,fprop_,options_]:=
  Module[{i,j,k,p=2,numer=False,Emat,th=1,h,qcoor,c,w,Nf,
   dNx,dNy,Jdet,B,Ke=Table[0,{10},{10}]},
  Emat=mprop[[1]];
  If [Length[options]==2, {numer,p}=options, {numer}=options];
  If [Length[fprop]>0, th=fprop[[1]]];
  If [p<1||p>4, Print["p out of range"]; Return[Null]];
  For [k=1, k<=p*p, k++,
       {qcoor,w}= QuadGaussRuleInfo[{p,numer},k];
       {Nf,dNx,dNy,Jdet}=Quad5IsoPShapeFunDer[ncoor,qcoor];
        If [Length[th]==0, h=th, h=th.Nf]; c=w*Jdet*h;
        B={ Flatten[Table[{dNx[[i]],       0},{i,5}]],
            Flatten[Table[{0,       dNy[[i]]},{i,5}]],
            Flatten[Table[{dNy[[i]],dNx[[i]]},{i,5}]]};
        Ke+=Simplify[c*Transpose[B].(Emat.B)];
      ]; Return[Ke];
   ];
```

```
Quad5IsoPShapeFunDer[ncoor_,qcoor_]:= Module[
  {Nf,dNx,dNy,dNξ,dNη,Nb,dNbξ,dNbη,J11,J12,J21,J22,Jdet,ξ,η,x,y},
  {ξ,η}=qcoor; Nb=(1-ξ^2)*(1-η^2); (* Nb: node-5 "bubble" function *)
   dNbξ=2*ξ(η^2-1); dNbη=2*η*(ξ^2-1);
   Nf= { ((1-ξ)*(1-η)-Nb)/4,((1+ξ)*(1-η)-Nb)/4,
         ((1+ξ)*(1+η)-Nb)/4,((1-ξ)*(1+η)-Nb)/4, Nb};
   dNξ={-(1-η+dNbξ)/4, (1-η-dNbξ)/4,
         (1+η-dNbξ)/4,-(1+η+dNbξ)/4, dNbξ};
   dNη={-(1-ξ+dNbη)/4,-(1+ξ+dNbη)/4,
         (1+ξ-dNbη)/4, (1-ξ-dNbη)/4, dNbη};
   x=Table[ncoor[[i,1]],{i,5}]; y=Table[ncoor[[i,2]],{i,5}];
   J11=dNξ.x; J21=dNξ.y; J12=dNη.x; J22=dNη.y;
   Jdet=Simplify[J11*J22-J12*J21];
   dNx= ( J22*dNξ-J21*dNη)/Jdet;  dNx=Simplify[dNx];
   dNy= (-J12*dNξ+J11*dNη)/Jdet;  dNy=Simplify[dNy];
   Return[{Nf,dNx,dNy,Jdet}]
];
```

Test `Quad5IsoPMembraneStiffness` for the 2:1 rectangular element studied in §23.3.1, with node 5 placed at the element center. Use Gauss rules 1 × 1, 2 × 2 and 3 × 3. Take $E = 96 \times 30 = 2880$ in lieu of $E = 96$ to get exact integer entries in $\mathbf{K}^{(e)}$ for all Gauss rules while keeping $\nu = 1/3$ and $h = 1$. Report on which rules give rank sufficiency. Partial result: $K_{22} = 3380$ and 3588 for the 2 × 2 and 3 × 3 rules, respectively.

EJERCICIO 2
ELEMENTO CUADRILATERO REGULAR DE 9 NODOS

001 EJERCICIO 2 CURSO 2005-06

EXERCISE 23.4

[C:25] Implement the 9-node biquadratic element for plane stress to get its 18×18 stiffness matrix. Follow the style of Figures 23.3–4 or E23.1–2. (The Gauss quadrature module may be reused without change.) Test it for the 2:1 rectangular element studied in §23.3.1, with nodes 5–8 placed at the side midpoints, and node 9 at the element center. For the elastic modulus take $E = 96 \times 39 \times 11 \times 55 \times 7 = 15855840$ instead of $E = 96$, along with $\nu = 1/3$ and $h = 1$, so as to get exact integer entries in $\mathbf{K}^{(e)}$. Use both 2×2 and 3×3 Gauss integration rules and show that the 2×2 rule produces a rank deficiency of 3 in the stiffness. (If the computation with `num=False` takes too long on a slow PC, set `num=True` and `Rationalize` entries as in Figure 23.8.) Partial result: $K_{11} = 5395390$ and 6474468 for the 2×2 and 3×3 rules, respectively.

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#31	#32	#33	#34	#35	#36	#37	#38	#39	#40
#41	#42	#43	#44	#45	#46	#47	#48	#49	#50
#51	#52	#53	#54	#55	#56	#57	#58	#59	#60
#61	#62	#63	#64	#65	#66	#67	#68	#69	#70
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Una vez completado, deberá subirse adecuadamente denominado a la cuenta de entrega personal, seleccionando del siguiente panel el enlace correspondiente al numero que se te ha asignado en la cuenta del material personalizado de la actividad ***m1-a1a***.

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