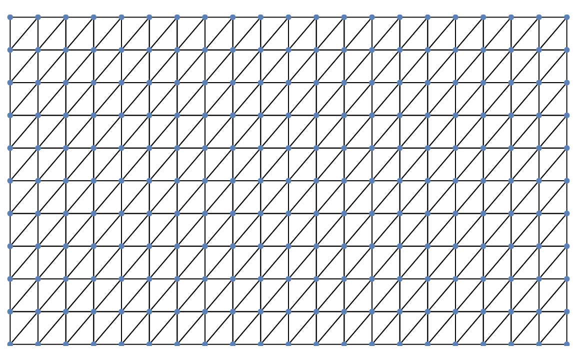
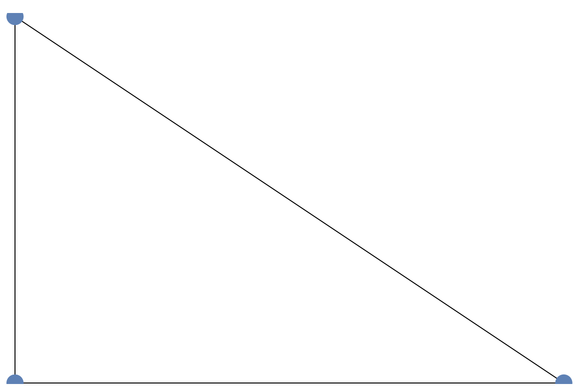
```
Nodes = {};
Offst1 = 5.0;
Offst2 = 5.0;
shwNodes = {};
i = 1;
xst = 0;
yst = 0;
While[xst < 100.25,
  While[yst < 50.25,
   Nodes = Append[Nodes, {i, xst, yst}];
   shwNodes = Append[shwNodes, {xst, yst}];
   If[yst < 50, (*50-5*)
    yst = yst + Offst1,
    yst = 51.(*51-6*)
   ];
   i++
  ];
  xst = xst + Offst2;
  yst = 0;
 ];

PtNodes = ListPlot[shwNodes, AspectRatio → Automatic];
Show[PtNodes];

Elem3 = {};

i = 1;
j = 1;
Coln = 10; (*50*)
ColLst = Table[i * 11, {i, 1, 20}]; (*51*)
While[ i ≤ 400, (*2501*)
 Elem3 = Append[Elem3, {i, j, j + Coln + 1, j + Coln + 2}];
 Elem3 = Append[Elem3, {i + 1, j, j + Coln + 2, j + 1}];
 j++;
 If[MemberQ[ColLst, j],
  j = j + 1
 ];
 i = i + 2;
];

nodes = {};
For[q = 1, q ≤ Length[Nodes], q++,
  AppendTo[nodes,
    {
     Nodes[[q]][[2]],
     Nodes[[q]][[3]]
    }
   ];
 ];

elements = {};
```

```
For[p = 1, p ≤ Length[Elem3], p++,
  AppendTo[elements,
    {
     Elem3[[p]][[2]],
     Elem3[[p]][[3]],
     Elem3[[p]][[4]]
    }
   ];
 ];

lines = {};
For[w = 1, w ≤ Length[elements], w++,
  AppendTo[lines,
   Line[{nodes[[elements[[w, 1]]]], nodes[[elements[[w, 2]]]],
     nodes[[elements[[w, 3]]]], nodes[[elements[[w, 1]]]]}]
  ]
 ];

RTriangle = {{0, 0}, {1, 0}, {0, 1}};
reflines = {};
AppendTo[reflines,
  Line[{RTriangle[[1]], RTriangle[[2]], RTriangle[[3]], RTriangle[[1]]}]
 ];
Print[Show[Graphics[lines], ListPlot[nodes, PlotStyle → PointSize[0.01]]],
  "Triangle FEM Geometry Model"];
Print[Show[Graphics[reflines], ListPlot[RTriangle, PlotStyle → PointSize[0.03]]],
  "Reference Triangle"];
```



Triangle FEM Geometry Model

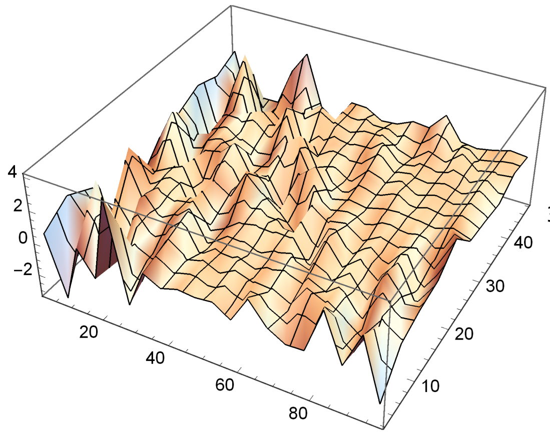


Reference Triangle

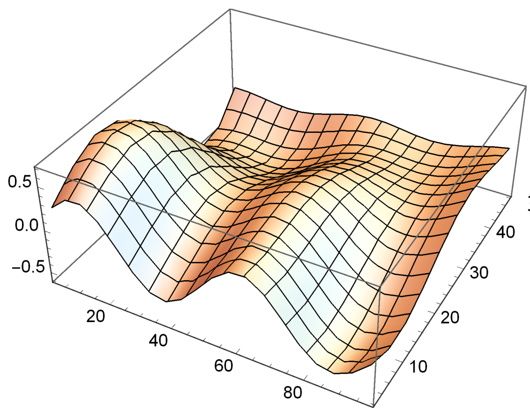
```
Vandermonde = ConstantArray[1, {Length[RTriangle], Length[RTriangle]}];
For[g = 1, g ≤ Length[Vandermonde], g++,

  Vandermonde[[g]][[2]] = RTriangle[[g]][[1]];
  Vandermonde[[g]][[3]] = RTriangle[[g]][[2]];

 ];

A = Vandermonde;
B = ConstantArray[0, Length[A]];
F = {};
K = ConstantArray[0, {Length[nodes], Length[nodes]}];
M = ConstantArray[0, {Length[nodes], Length[nodes]}];

For[i = 1, i ≤ Length[A], i++,
  B[[i]] = 1;
  AppendTo[F, LinearSolve[A, B].{1, x, y}];
  B[[i]] = 0;
 ];

a = γ - α;
b = δ - β;
c = μ - α;
d = ν - β;

T = {{a, c}, {b, d}};

{inverse1, inverse2} =
  Ainverse[α_, β_, γ_, δ_, x_, y_] = Inverse[T].{x, y} - Inverse[T].{α, β};

For[k = 1, k ≤ Length[elements], k++,
  For[m = 1, m ≤ Length[F], m++,
    For[n = 1, n ≤ Length[F], n++,

      elementcounter = elements[[k]];
      columns = elementcounter[[n]];
      rows = elementcounter[[m]];

      α = nodes[[elements[[k]]]][[1]][[1]];
      β = nodes[[elements[[k]]]][[1]][[2]];
      γ = nodes[[elements[[k]]]][[2]][[1]];
      δ = nodes[[elements[[k]]]][[2]][[2]];
      μ = nodes[[elements[[k]]]][[3]][[1]];
      ν = nodes[[elements[[k]]]][[3]][[2]];

      F_m[x_, y_] = F[[m]];
      F_n[x_, y_] = F[[n]];

      P_m[x_, y_] = Simplify[F_m[inverse1, inverse2]];
      P_n[x_, y_] = Simplify[F_n[inverse1, inverse2]];
```

```
      Gₘ = Grad[Pₘ[x, y], {x, y}];
      Gₙ = Grad[Pₙ[x, y], {x, y}];

      Hₘ = Pₘ[x, y];
      Hₙ = Pₙ[x, y];

      If[Mod[k, 2] ≠ 0,
       K[[rows, columns]] = K[[rows, columns]] +
         Integrate[Dot[Gₘ, Gₙ], {x, α, γ}, {y, β, ((ν - β) / (μ - α)) (x - α) + β}];
       M[[rows, columns]] = M[[rows, columns]] + NIntegrate[Times[Hₘ, Hₙ],
           {x, α, γ}, {y, β, ((ν - β) / (μ - α)) (x - α) + β}];
      ];

      If[Mod[k, 2] == 0,
       K[[rows, columns]] = K[[rows, columns]] +
         Integrate[Dot[Gₘ, Gₙ], {x, α, γ}, {y, ((δ - β) / (γ - α)) (x - α) + β, ν}];
       M[[rows, columns]] = M[[rows, columns]] + NIntegrate[Times[Hₘ, Hₙ],
           {x, α, γ}, {y, ((δ - β) / (γ - α)) (x - α) + β, ν}];
      ];
     ];
   ];
  ];
```

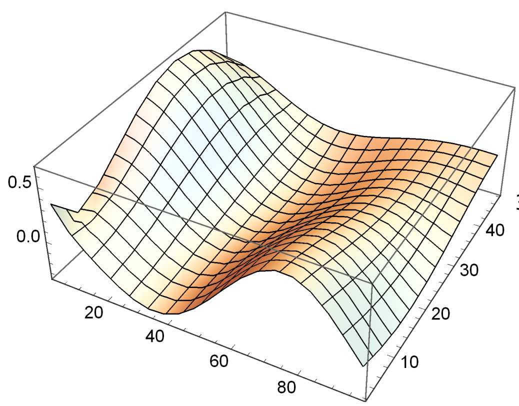
```
dirichlet = ConstantArray[0, Length[nodes]];
dirichlet[[1]] = 1;
K[[1]] = dirichlet;
M[[1]] = dirichlet;

evectors = Eigenvectors[{K, M}];
rise = ConstantArray[0, Length[elements]];
plots = ConstantArray[0, Length[nodes]];

For[λ = 1, λ ≤ Length[nodes], λ++,
  For[v = 1, v ≤ Length[elements], v++,

   elementcounter = elements[[v]];

   α = nodes[[elements[[v]]]][[1]][[1]];
   β = nodes[[elements[[v]]]][[1]][[2]];
   γ = nodes[[elements[[v]]]][[2]][[1]];
   δ = nodes[[elements[[v]]]][[2]][[2]];
   μ = nodes[[elements[[v]]]][[3]][[1]];
   ν = nodes[[elements[[v]]]][[3]][[2]];

   centerx = (α + γ) / 2;
   centery = (β + ν) / 2;

   rise[[v]] = {centerx, centery, evectors[[λ]][[elementcounter[[1]]]] * P1[x, y] +
       evectors[[λ]][[elementcounter[[2]]]] * P2[x, y] +
       evectors[[λ]][[elementcounter[[3]]]] * P3[x, y] /. {x → centerx, y → centery}};

  ];
  plots[[λ]] = ListPlot3D[rise, PlotRange → All];
 ];

timestart = 1;
timefinish = Length[plots];
time = RandomInteger[{timestart, timefinish}];
time1 = RandomInteger[{time, timefinish}];
time2 = RandomInteger[{time1, timefinish}];

Print[plots[[time]], "3D Plot solution for randomly generated λ = ", time];
Print[plots[[time1]], "3D Plot solution for randomly generated λ = ", time1];
Print[plots[[time2]], "3D Plot solution for randomly generated λ = ", time2];
```



3D Plot solution for randomly generated λ = 68



3D Plot solution for randomly generated λ = 223



3D Plot solution for randomly generated λ = 226