Helmholtz Equation

The Holmholtz equation or frequency domain wave equation is

$$-\Delta u - \omega^2 u = f$$

we consider Dirichlet ("hard") boundary conditions

$$u(x) = 0$$

and Robin ("absorbing") boundary conditions

$$\frac{\partial u}{\partial n} + i\omega u = 0 \qquad \text{on } \Gamma_R$$

The weak form is

$$\int_\Omega \nabla u \nabla v - \omega^2 uv + i\omega \int_{\Gamma_R} uv = \int_\Omega fv$$

In [1]:
```
import netgen.gui
from ngsolve import *
%gui tk
```

In [2]:
```
from netgen.geom2d import unit_square
mesh = Mesh(unit_square.GenerateMesh(maxh=0.05))

from math import pi
```

In [3]:
```
fes = H1(mesh, order=5, complex=True)
u = fes.TrialFunction()
v = fes.TestFunction()
a = BilinearForm(fes)
f = LinearForm(fes)

omega = 2*pi*20
a += SymbolicBFI (grad(u)*grad(v)-omega**2*u*v)
a += SymbolicBFI (-1j*omega*u*v, BND)
f = LinearForm(fes)

source = exp(-50**2*((x-0.5)*(x-0.5)+(y-0.5)*(y-0.5)))
f += SymbolicLFI(source*v)

a.Assemble()
f.Assemble()

gfu = GridFunction(fes)
gfu.vec.data = a.mat.Inverse(fes.FreeDofs()) * f.vec
Draw (gfu)
```

In [4]:
```
fes = H1(mesh, order=8, complex=True)
u = fes.TrialFunction()
v = fes.TestFunction()
a = BilinearForm(fes)
f = LinearForm(fes)

omega = 2*pi*20
a += SymbolicBFI (grad(u)*grad(v)-omega**2*u*v)
a += SymbolicBFI (-1j*omega*u*v, BND)
f = LinearForm(fes)

source = exp(-10**2*(y-0.5)*(y-0.5))
f += SymbolicLFI(source*v, definedon=mesh.Boundaries("left"))

a.Assemble()
f.Assemble()

gfu = GridFunction(fes)
gfu.vec.data = a.mat.Inverse(fes.FreeDofs()) * f.vec
Draw (gfu)
```