# ISC 5935 - Computational Tools for Finite Elements
Homework #6
Assigned 15 October 2014, Due 22 October 2014
http://people.sc.fsu.edu/~jburkardt/classes/fem_2014/homework6.pdf

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1. Get a copy of the python program **fem2d_bvp_linear.py** from
**http://people.sc.fsu.edu/~jburkardt/py_src/fem2d_bvp_linear/fem2d_bvp_linear.html**
which solves the problem:

$$-u_{xx} - u_{yy} = f(x, y)$$
$$0 < x < 1, \quad 0 < y < 1$$
$$u(*, 0) = u(*, 1) = u(0, *) = u(1, *) = 0$$

This program uses quadrilateral elements and bilinear basis functions. Modify the program so that the exact solution is

$$u(x, y) = \sin(2\pi x) \cos(\pi y)$$

over the same region, the unit square. You will need to determine the corresponding $f(x, y)$ for this problem, and modify the function **rhs_fn()**. You still want to use Dirichlet boundary conditions, but the boundary value will not be 0 everywhere. You can modify the function **exact_fn()**; then figure out where you need to call that function in order to enforce the boundary conditions.

**Turn in:** the print-out from the program.

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2. Get a copy of the Fenics program **bvp_06.py** from
**http://people.sc.fsu.edu/~jburkardt/examples/fenics/bvp_06.py**
which is set up to solve the same problem as **fem2d_bvp_linear.py**. Modify this file in a similar way, so that the exact solution is

$$u(x, y) = \sin(2\pi x) \cos(\pi y)$$

Use the 4x4 element mesh generated by the **UnitSquareMesh()** function, and use piecewise continuous Lagrange elements of order 1 (linears).

Modify the program to print the exact and finite element solutions on a 5x5 mesh of nodes from (0,0), (1/4,0) ..., (1,1).

**Turn in:** the print-out from the program.

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3. Modify your program from problem 2 so that it computes the L2 norm of the error, that is $||u(x, y) - u^h(x, y)||$. Then report this error when using:

- 4x4 element grid, piecewise linear basis functions (order = 1);

- 8x8 element grid, piecewise linear basis functions (order = 1);

- 4x4 element grid, piecewise quadratic basis functions (order = 2);

- 4x4 element grid, piecewise cubic basis functions (order = 3).

**Turn in:** the print-out from the program.