Homework 3

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NUEN 629

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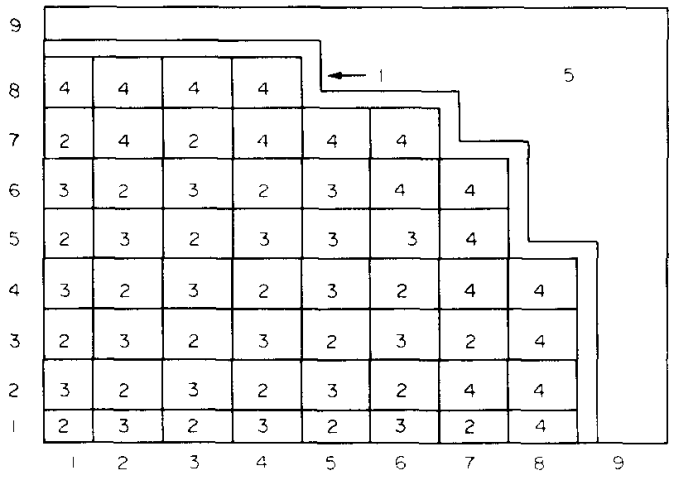
NUEN 629, Homework 3

Due Date Oct. 23

Solve the following problem and submit a detailed report, including a justification of why a reader should believe your results and a description of your methods and iteration strategies.

1 Goth and Hammer

(150 points + 50 points extra credit) The Zion PWR Benchmark (K.S. Smith, NSE, 1986), is a 2-D, two-group, reactor benchmark calculation where a quarter reactor is specified by the following figure:



Composition	Group, g	D_g	Σ_{ag}	$\nu\Sigma_{fg}$	$\Sigma_{gg'}$
1	1	1.02130	0.00322	0.0	0.0
	2	0.33548	0.14596	0.0	0.0
2	1	1.47160	0.00855	0.00536	0.01742
	2	0.37335	0.06669	0.10433	0.0
3	1	1.41920	0.00882	0.00601	0.01694
	2	0.37370	0.07606	0.12472	0.0
4	1	1.42650	0.00902	0.00653	0.01658
	2	0.37424	0.08359	0.14120	0.0
5	1	1.45540	0.00047	0.0	0.02903
	2	0.28994	0.00949	0.0	0.0

$X_1 = 1.0$, $X_2 = 0.0$.
Assembly pitch: 21.608 cm. Baffle thickness: 2.8575 cm.
Boundary condtions: reflective: left, bottom, zero flux: top, right.
$\Sigma_{tr,g} = 1/3D_g$ for isotropic scattering, transport problem.

Figure 1: Zion PWR benchmark from K.S. Smith, NSE, 1986.

Solution 1-1:

The 2D lattice input code provided in lab was modified to generate the input for the first benchmark problem. Because the provided code assumes a uniform mesh size, approximations must be made to resolve the baffle in the geometry. I have assumed that if a particular cells center lies with in the region of the baffle, then that cell has the baffle material properties. Also, I have assumed that the assemblies near the reflecting boundary are full assemblies, rather than half assemblies. To match the edges of the assembly exactly, I used numbers of cells in the x and y direction that are factors of 9. It is noted that this will cause a jump in convergence of the solution in terms of mesh size, caused at points where the cell widths are small enough that an additional baffle cell can be inserted.

The assembly power is averaged over each cell in a 9x9 grid over the quarter reactor, weighted by $\nu\Sigma_f$ in each group. Since we do not know Σ_f individually this is not exact since ν is larger for the fast group, generally. Since we are normalizing, this is not a great error, and produces a zero assembly power in the water regions as desired.

A convergence table versus mesh size as a function of the number of cells is given below. The change in k_{eff} appears to increase above 1296 cells. This is possibly due to the approximation of the baffle as explained above, however a run without the baffle produced similar results. Although it is possible that the

Table 1: Convergence table for finite difference method versus number of mesh cells.

81	1.2786193689	–
324	1.27611471632	0.00250465258332
729	1.27609454035	2.01759703702e-05
1296	1.27623214214	0.00013760179336

Figure 1: Material ID's for Problem 1. There is a slight error due to how pcolor interpolates linear values at cell centers, so the entire picture is shifted

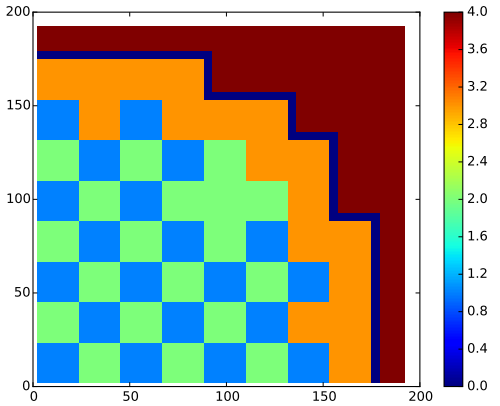


Figure 2: Normalized group 1 fluxes for finite difference solution

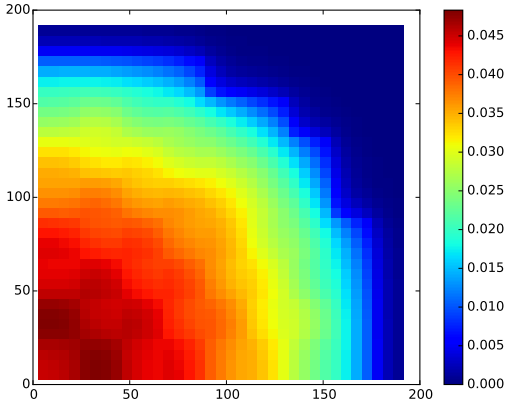


Figure 3: Normalized group 2 fluxes for finite difference solution

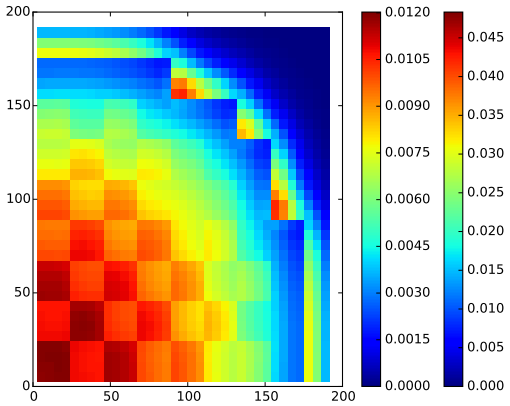


Figure 4: Assembly (assuming 9x9 grid) averaged powers for problem 1, normalized to the max assembly power, solved using finite differences.