Analysis of Reactor Static Characteristics

2008 년 2 학기

Project 3: B1 Leakage Correction

Due Dec. 4, 2008

In order to find the critical leakage the B_1 method, the following 0-D multigroup eigenvalue problem needs to be solved:

$$\left(\mathbf{D}B^2 + \mathbf{\Sigma_t} - \mathbf{S}_0\right)\mathbf{\Phi} = \frac{1}{k}\mathbf{F}\mathbf{\Phi} \qquad (6)$$

where **D** is the diffusion matrix which is the inverse of the following diagonally modified P1 scattering matrix:

$$\mathbf{D}^{-1} = \begin{bmatrix} \alpha(B,\Sigma_{t1})\Sigma_{t1} - \Sigma_{11}^{(1)} & -\Sigma_{21}^{(1)} & \cdots & -\Sigma_{G1}^{(1)} \\ -\Sigma_{12}^{(1)} & \alpha(B,\Sigma_{t2})\Sigma_{t2} - \Sigma_{22}^{(1)} & & -\Sigma_{G2}^{(1)} \\ \vdots & & \ddots & \vdots \\ -\Sigma_{1G}^{(1)} & -\Sigma_{2G}^{(1)} & \cdots & \alpha(B,\Sigma_{tG})\Sigma_{tG} - \Sigma_{2G}^{(1)} \end{bmatrix} \qquad (7)$$

Note that the diffusion matrix is function of buckling through the α parameter which takes the form of either *arctan* or *ln* depending on the sign of B^2. The critical buckling that would give *k=1* needs to be searched.

1. Prepare an input processing routine that reads in the multigroup cross section data which are given in the following format.

```
47 Group Xsecs
   g              E            Abs           Scat         nu-Fis            Chi           Flux
  Tot         Trans     TrC-SM-gg      TrC-Scat
   1   2.000000E+07   6.645822E-03   1.233815E-01   2.324442E-02   2.551374E-02   2.517108E-01
  1.300273E-01   7.343034E-02   1.044663E-03   6.678451E-02
   2   6.065300E+06   6.192969E-03   1.604575E-01   1.261388E-02   1.106268E-01   1.049202E+00
  1.666505E-01   8.983538E-02   8.758643E-03   8.364241E-02
    .
    .
  47   1.239596E-02   3.630231E-01   2.928799E+00   6.547721E-01   0.000000E+00   4.859305E-02
  3.291822E+00   3.079324E+00   9.758364E-01   2.716301E+00
Scatttering Matrix
 from   to           P0           P1
   1    1   5.764166E-02   4.126963E-02
   1    2   2.417913E-02   7.131560E-03
   2    2   8.557375E-02   5.684755E-02
   1    3   1.186071E-02   4.223010E-03
   2    3   3.358886E-02   9.396597E-03
    .
    .
  46   47   2.119799E-01   1.095688E-01
  47   47   1.188334E+00   3.158999E-01
```

Note that the cross section data for a group are given in one line, not two lines as appeared above due to the page width limitation. ‘TrC’ above means transported corrected. The

scattering matrix would contain upscattering components.

2. Write a routine that constructs the modified P1 scattering matrix ($\mathbf{D}^{-1}$) as a function of Buckling and total cross section. Refer to the MATLAB function attached at the end to determine the alpha values. Then write a routine that finds the inverse of $\mathbf{D}^{-1}$ by repeated solutions of the linear system involving $\mathbf{D}^{-1}$ with the RHS replaced with elementary vectors.

3. Write a routine that solves the eigenvalue problem (7). Note that you don't need to actually construct fission matrix because you only need the fission spectrum and the normalized fission source. The spectrum obtained with zero leakage should be close to the groupwise fluxes given in the input file once they are normalized. The multiplication factor for this case is 1.40108.

4. Implement a search algorithm that changes the buckling value to find the unity eigenvalue. Use this algorithm to find the critical buckling. Then determine the current spectrum and consequently the diffusion coefficient for each group.

5. Compare the critical spectrum with the zero-leakage spectrum and discuss the difference in the spectra. Compare the flux and current spectra at the critical condition. Compare the diffusion coefficients obtained with the transport cross section based values and discuss the importance of the leakage correction.

6. Prepare a self explanatory report about the method, coding and the results.

Function for α

```
function x=falpha(Bsq,sigt)
if(Bsq>0)
    B=sqrt(Bsq);
    a00=atan(B/sigt)/B;
else
    B=sqrt(-Bsq);
    a00=log((sigt+B)/(sigt-B))/(2*B);
end
x=a00*Bsq/sigt/(3*(1-a00*sigt));
```