NE 806, Neutronics

Homework Set 2 **Fall 2018**

due: 4 October 2018 **Name:** _____

1. Four parallel neutron beams have identical intensities of 3×10^6 neutrons cm^2 s^{-1} and intersect within a volume V about the origin. The four beams are monoenergetic at the energy E_0. The first beam is in the x-direction, the second beam is in the -y-direction, the third beam is in the z-direction, and the fourth beam is in a direction given by

   $$\hat{\mathbf{\Omega}} = 0.5000\hat{\mathbf{i}}_x + 0.7071\hat{\mathbf{i}}_y + 0.5000\hat{\mathbf{i}}_z .$$

   (a) (5 points) What is the flux density at every point in the volume V?

   (b) (5 points) What is the current density at every point in the volume V?

   (c) (5 points) What is the magnitude of the current density at every point in V?

   (d) (5 points) What is the net number of neutrons crossing unit area in V in the y-direction?

2. You have determined that the angular flux density in a given problem can be expressed as

   $$\varphi(x,\mu) = 40{,}000e^{-x/3}\left[2+\sin(x\mu/3)\right] \text{ for } 0\le x\le 10,\ -1\le\mu\le 1$$

   (a) (10 points) Use Monte Carlo to estimate total flux density at $x = x_0 = 5$.

   (b) (10 points) Give the precision of your estimate.

3. Lambert's law states that the angular intensity of the radiation leaving a surface varies as the cosine, ω, of the angle between the outward normal and the radiation direction. Consider a medium that emits neutrons from the surface into a vacuum according to Lambert's law.

   (a) (5 points) What is the PDF for ω?

   (b) (5 points) What is the CDF for ω?

   (c) (5 points) What is the mean value of ω?

   (d) (5 points) What fraction of neutrons are emitted at angles between 30° and 45°?

4. (40 points) Consider a critical slab reactor of width T = 1 mfp. Assume a quadrature has been applied to the NTE that leads to the eigenvalue equation

   $$\mathbf{B\Phi} = \lambda\mathbf{\Phi},$$

   with $\lambda = \dfrac{2}{c}$ and **B** given as follows

0.5109	0.1823	0.1223	0.0906	0.0702	0.056	0.0454	0.0374	0.0311	0.026
0.1823	0.3555	0.1823	0.1223	0.0906	0.0702	0.056	0.0454	0.0374	0.0311
0.1223	0.1823	0.3564	0.1823	0.1223	0.0906	0.0702	0.056	0.0454	0.0374
0.0906	0.1223	0.1823	0.3568	0.1823	0.1223	0.0906	0.0702	0.056	0.0454
0.0702	0.0906	0.1223	0.1823	0.357	0.1823	0.1223	0.0906	0.0702	0.056
0.056	0.0702	0.0906	0.1223	0.1823	0.357	0.1823	0.1223	0.0906	0.0702
0.0454	0.056	0.0702	0.0906	0.1223	0.1823	0.3568	0.1823	0.1223	0.0906
0.0374	0.0454	0.056	0.0702	0.0906	0.1223	0.1823	0.3564	0.1823	0.1223
0.0311	0.0374	0.0454	0.056	0.0702	0.0906	0.1223	0.1823	0.3555	0.1823
0.026	0.0311	0.0374	0.0454	0.056	0.0702	0.0906	0.1223	0.1823	0.5109

Use the power method to estimate c_{crit} to four decimal places. Show your work.