NE 583 Radiation Transport Methods

Final Exam (Take Home)

Due 11:59 p.m., Saturday, December 9, 2019

Email the results to me by the deadline in a single PDF file attachment. (No clouds, zips, EXCELs, or coding files.)

[20] 1. Use the S_2, S_4, and S_8 quadratures to determine three (successively more accurate) estimates to the value of the integral: [True value ~= 1443.0824]

$$I = \int_1^3 e^{x^2} dx$$

[20] 2. Show (e.g., by substitution) the assertion that the 1D characteristic method is equivalent to weighted diamond difference with a weight of

$$\alpha = \frac{1}{1-e^{-\tau}} - \frac{1}{\tau}; \quad \text{where } \tau = \frac{\sigma_{\mathrm{ti}} \Delta x_i}{\mu_n}$$

[20] 3. Define the S_{10} level symmetric quadrature by giving the direction cosines for the 15 directions in the first octant. Let μ_1 be 0.08.

[15] 4. Describe what "ray effects" are, why they arise, and how we deal with them.

[15] 5. Verify Eq. 5-38 in the text from Eq. 5.37. I am going to grade this fairly strictly. Do not skip steps. Specifically:

a. Make no physically simplifying assumptions or physical arguments.
b. Do not utilize the recurrence relation A-43 unless you have a term that fits the form EXACTLY.
c. For change of variable from x to τ, you may need to use the Leibnitz formula:

$$\frac{d}{d\alpha} \int_{g(\alpha)}^{h(\alpha)} f(x,\alpha) dx = \int_{g(\alpha)}^{h(\alpha)} \frac{\partial f(x,\alpha)}{\partial \alpha} dx + f[h(\alpha),\alpha] \frac{dh(\alpha)}{d\alpha} - f[g(\alpha),\alpha] \frac{dg(\alpha)}{d\alpha}$$

[20] 6. Find the required fuel half-thickness *t* in the slab reactor lattice to produce a k-infinity of 1.30. Use 1D integral transport, just the two spatial regions (infinitely reflected), and assume isotropic scattering. (Hint: The probability that a neutron released in the fuel has its next collision in a fuel region + the probability that it has its next collision in a moderator region has to equal 1.00.) Explain what you are doing (rather than just writing down an equation and using it).

The 1 group cross sections are:

Fuel:	Total 0.46	Scattering 0.40	nu*Fission 0.10
Moderator:	Total 0.91	Scattering 0.90