NE 583 Radiation Transport

Final Exam (Take Home)

Due midnight, Tuesday, December 13, 2022

1. Using ONLY EXCEL (with no external macros—start with an empty worksheet) and the recurrence relation for Legendre polynomials:

$$P_n(x) = \frac{(2n-1)xP_{n-1}(x) - (n-1)P_{n-2}(x)}{n}$$

find the POSITIVE zeros of $P_{18}(x)$ in the range (0,1). (Include the spreadsheet with your submission—in fact, it can be the whole submission for this problem.)

2. I left out of the point kinetics derivation how the term:

$$\beta_i \langle \nu \sigma_f \psi \rangle$$

on slide 12-16 becomes the term:

$$\frac{\beta_i}{\Lambda} n(t)$$

on slide 12-12. Show that these are the same. (You may use any equation from Lecture 12 without having to derive it.)

3. Solve the Class Exercise defined in Slide 9 for the average flux in Group 1 in the range x=45 to x=50 cm. using integral transport theory. (HINT: The discrete ordinates solution for S16 is 0.00226, so you should be close to this.)

4. Verify Eqns. 5-38 and 5-39 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.

Extra credit: Why did they choose mu_1=0.2182179 for the S_8 quadrature in Table 4-1?

IMPORTANT: Include with your submission a statement that this test is your OWN WORK, and you neither sought nor gave any help from/to anyone but Dr Pevey.

5.1.53 $\quad 0 \leq x \leq 1$

$$E_1(x)+\ln x=a_0+a_1x+a_2x^2+a_3x^3+a_4x^4+a_5x^5+\epsilon(x)$$

$$|\epsilon(x)|<2\times10^{-7}$$

$$\begin{array}{ll} a_0=-.57721\ 566 & a_3=\ \ .05519\ 968 \\ a_1=\ \ .99999\ 193 & a_4=-.00976\ 004 \\ a_2=-.24991\ 055 & a_5=\ \ .00107\ 857 \end{array}$$

5.1.54 $\quad 1 \leq x < \infty$

$$xe^xE_1(x)=\frac{x^2+a_1x+a_2}{x^2+b_1x+b_2}+\epsilon(x)$$

$$|\epsilon(x)|<5\times10^{-5}$$

$$\begin{array}{ll} a_1=2.334733 & b_1=3.330657 \\ a_2=\ \ .250621 & b_2=1.681534 \end{array}$$

5.1.14

$$E_{n+1}(z)=\frac{1}{n}\left[e^{-z}-zE_n(z)\right] \quad (n=1,2,3,\ldots)$$