Problem Set 01

[10] 1. Write down a differential equation for the time-dependent, continuous-energy, neutron diffusion equation in a multiplying media, without a source term. Describe what each term represents.

[15] 2. Evaluate the following complex integral by integrating over the left half of the complex plane. γ is an arbitrary constant that ensures that all singularities are within the integration contour. a and b are positive, arbitrary, real constants.

$$I = \frac{1}{2\pi \mathrm{i}} \int_{\gamma-\mathrm{i}\infty}^{\gamma+\mathrm{i}\infty} \frac{e^{s\,t}}{(s+a)(s+b)} ds$$

HINT: It will be easier to use a change of variable to recenter the complex plane around γ, such as $s = \gamma + \mathrm{i}\omega$.

[15] 3. A one-dimensional slab reactor consists of two regions: a multiplying core of length a, and vacuum outside of the core. Using one-group diffusion theory, determine a such that the reactor will be critical. Express a in terms of relevant nuclear properties.

[15] 4. Use a computer to plot the solution to the following coupled ODEs. Plot $y(t)$ and $x(t)$ on the same graph for $t \in [0, 10]$.

$$\begin{aligned} \frac{dy}{dt} &= 0.4\,x(t) - y(t) \\ \frac{dx}{dt} &= -0.4\,y(t) \end{aligned} \quad , \quad \begin{aligned} y(0) &= 1 \\ x(0) &= 0 \end{aligned}$$