ENGINEERING PHYSICS 4D3 Assignment #5 Set:
Due:

1. [Duderstadt & Hamilton 5-31]
A homogeneous one-speed bare reactor has a cylindrical configuration. Determine :
a) the radius and length of the reactor as functions of the buckling so that the volume of the critical reactor, and hence its mass, is a minimum;
b) the minimum volume as a function of buckling.

2. [Duderstadt & Hamilton 5-36]
A bare spherical reactor is to be constructed of a homogeneous mixture of D_2O and U^{235}. The composition is such that for every uranium atom there are 2000 heavy water molecules (i.e., $N^{D2O} / N^{25} = 2000$). Calculate:
a) the critical radius of the reactor using one-speed diffusion theory (data: $\eta^{25} = 2.06$, $D_{D2O} = 0.87$ cm., $\Sigma_a^{D2O} = 3.3 \times 10^{-5}$ cm.-1, $\sigma_a^{D2O} = 0.001$ b, and $\sigma_a^{25} = 678$ b.);
b) the mean number of scattering collisions made by a neutron during its lifetime in this reactor.

3. [Duderstadt & Hamilton 5-37]
There is a strong motivation to obtain as flat a power distribution as possible in a reactor core. One manner in which this may be accomplished is to load a reactor with a nonuniform fuel enrichment. To model such a scheme, consider a bare, critical slab reactor as described by one-speed diffusion theory. Determine the fuel distribution $N_f\,(x)$ which will yield a flat power distribution $P(x) = w_f\,\Sigma_f\,(x)\,\varphi\,(x) = \text{constant}$. For convenience, assume that fuel only absorbs neutrons and that it does not significantly scatter them. Also assume that all other materials in the core are uniformly distributed.

4. [Midterm 1990]
Consider a rectangular tank containing a homogeneous mixture of liquid fuel and moderator.
a) What is the theoretical (predicted) height, h, in terms of the length and width, a and b, and the material properties Σ_a, D and $\nu\Sigma_f$. Assume one-group diffusion theory.
b) Assign errors to the measured parameters, Σ_a, D and $\nu\Sigma_f$. Discuss the resultant error in height (measured vs. predicted).