

MAE 118C Spring Quarter 2008
Professor G.R. Tynan

PRACTICE MIDTERM

1. Two nuclear particles with rest mass M_a and M_b and incident kinetic energies E_a and E_b interact to yield two other nuclear particles with rest mass M_c . The masses are such that $M_a + M_b > 2M_c$. Find the kinetic energy of the two particles that are formed in the interaction.
2. A monoenergetic beam of particles with intensity I_0 is incident on a slab target of thickness d . The number density of nuclei in the target is N and the microscopic cross section for interactions between beam particles and target nuclei is given as σ .
 - a. Write down the macroscopic cross section.
 - b. Derive the differential equation for the intensity for the un-interacted beam intensity at a depth x into the target.
 - c. Solve this equation, and evaluate it to find the intensity of un-interacted beam particles exiting the slab.
3. The neutron flux at a certain point in a nuclear reactor is given as ϕ . The macroscopic fission cross section is given as Σ_f and energy release per fission event is E_f . What is the power density at this point in the reactor?
4. An infinite moderator medium with macroscopic absorption cross-section Σ_a contains two slab sources of neutrons at positions $x=+a$ and $x=-a$. Both sources have a strength S . Find an expression for the neutron current density, $J_x(x)$ within the moderator material.
 - a. Either write down the flux for a single source with strength S located at $x=0$, or derive it from the steady-state diffusion equation which is given as $D\nabla^2\phi(x) - \Sigma_a\phi(x) = -S(x)$.
 - b. Use the Fick's law diffusion assumption to find J_x in terms of the flux.
 - c. Find the unknown coefficient in terms of the source strength S .
 - d. Now translate this single source to a position of either $x=+a$ and to $x=-a$ to find the current density for both cases separately, and then superpose the solutions to find the total current density for the original problem of two slab sources of neutrons at positions $x=+a$ and $x=-a$ immersed within an infinite absorbing moderator.
5. If the average number of neutrons released during a fission event is given as ν , the macroscopic fission cross-section is Σ_f and the absorption cross section is Σ_a , what is the condition that must be satisfied to maintain a steady-state rate of fission in an infinite reactor core.