ENGINEERING PHYSICS 4D3/6D3

DAY CLASS — Dr. Wm. Garland

DURATION: 20 minutes

McMASTER UNIVERSITY QUIZ #1 — October 16, 2001

Special Instructions: Closed Book. All calculators and up to 6 single sided 8 ½" by 11" crib sheets are permitted.

THIS EXAMINATION PAPER INCLUDES 1 PAGE AND 1 QUESTION.

1. Consider an infinite media consisting of a homogeneous mixture of Carbon, H_2O and Aluminum such that $\Sigma_a = 1.0 \times 10^{-3}$ cm^{-1}. The medium also contains an evenly distributed source of neutrons, S = 100 neutrons/cm^3 sec.
   a. [30 marks] What is the governing neutron balance equation appropriate for this case?
   b. [10 marks] What are the appropriate initial and boundary conditions?
   c. [10 marks] What is the steady state neutron flux?
   d. [50 marks] Calculate the neutron flux as a function of time. For this problem, assume all neutrons are thermal (2200 m/s) and that the initial flux is 0.0 neutrons/cm^2 sec.

a. $\frac{1}{v}\frac{\partial \phi(t)}{\partial t} = S - \Sigma_a \phi(t)$ [$\nabla \cdot D \nabla \phi$ term $\rightarrow 0$ since infinite media]

b. $\phi(0) = 0.0$ (Initial condition)
No boundary Conditions since there are no boundaries.

c. At S.S. $\frac{\partial \phi}{\partial t} = 0 \Rightarrow \phi(\infty) = \frac{S}{\Sigma_a} = \frac{100\ n/cm^3\text{-}s}{1.0 \times 10^{-3}\ cm^{-1}}$
$= 10^5\ n/cm^2\text{-}s$

d. Try $\phi = A + C e^{-\alpha t}$
sub into differential eqn: $\frac{1}{v} C(-\alpha) e^{-\alpha t} = S - \Sigma_a A - \Sigma_a C e^{-\alpha t}$
$\therefore A = S/\Sigma_a$ and $-\frac{1}{v} C\alpha = -\Sigma_a C \Rightarrow \alpha = v\Sigma_a$
$\therefore \phi = \frac{S}{\Sigma_a} + C e^{-v\Sigma_a t} = 0$ at $t=0 \Rightarrow C = -\frac{S}{\Sigma_a}$
Thus: $\phi = \frac{S}{\Sigma_a}\left(1 - e^{-v\Sigma_a t}\right) = 10^5\left(1 - e^{-2.2\times10^5\ cm/s \times 1.0\times10^{-3}\ cm^{-1} t}\right)$

$\phi = 10^5\left(1 - e^{-2.2\times10^2 t}\right)\ n/cm^2 s$