872.

Problem 55.23 (RHK)

The neutron generation time t_{gen} *in a reactor is the average time between one fission and the fissions induced by the neutrons emitted in that fission. Suppose that the power output of a reactor at time* $t = 0$ *is* P_0. *We have to show that the power output a time t later is* $P(t)$, *where*

$$P(t) = P_0 k^{t/t_{\text{gen}}},$$

where k is the multiplication factor. Note that for constant power output $k = 1$.

Solution:

The multiplication factor in a nuclear power reactor is the ratio of number of neutrons present at the beginning of a particular generation to the number of neutrons present at the beginning of the next generation.

Let the number of neutrons present which trigger nuclear fission process at $t = 0$ be *N*. It is given that the power output at $t = 0$ is P_0.

The neutron generation time t_{gen} in a reactor is the average time between a fission and the fissions induced by the neutrons emitted in that fission.

Between the times $t = 0$ and $t = t$ later, t/t_{gen} fission generations would have occurred. Therefore, at time t the number of neutrons present for triggering the nuclear fission process then will be

$$N(t) = Nk^{t/t_{\text{gen}}} .$$

The power output due to fission in the nuclear reactor at time t will therefore be

$$P(t) = P_0 k^{t/t_{\text{gen}}} .$$