NE450 - Principles of nuclear engineering
Project 1 - Nuclear engineering basics

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Total - 100

(1) (20) The Poisson distribution describes radioactive decay. It is a specific form of the binomial distribution. Derive the Poisson distribution from the binomial distribution. Derive the first and second (central) moments of the Poisson distribution. Briefly comment on their significance. Check out the Risk assessment OER for more information.

(2) (20) Find the binding energy per nucleon for ^{235}U and ^{252}Cf. Which radionuclide do you think is more likely to spontaneously fission and why?

(3) (20) Derive the decay equation for a three member chain (A, B, C), where the third member is a stable nuclide. At what time is the activity of B maximized? Based on the three member decay chain, when will secular equilibrium be reached if $\lambda_A \ll \lambda_B$ or if $\lambda_B \ll \lambda_A$ Discuss why secular equilibrium is useful.

(4) (20) Derive the decay equation for an N member chain, where the Nth member is a stable nuclide. Do it out for at least a fourth member. Plot [*log-log*] the ^{238}U decay chain for $0 < t < 10^8\ y$. Does ^{222}Rn reach secular equilibrium with ^{238}U? Note any interesting observations and subsequent implications.

(5) (20) You are given an unknown radioactive sample. (See Table 1.) You record 'average counts;' i.e., disintegrations per second, every 30 seconds, for 10 minutes. Using these data, what radionuclide is this? Plot [*semi-log*] the data with error bars; i.e., $\bar{c} \pm 1\ \sigma$.

Table 1: Average counts for unknown radioactive sample.

Time(s)	Counts per second
0	1000
30	856.7
60	734.0
90	628.8
120	538.8
150	461.6
180	395.4
210	338.8
240	290.3
270	248.7
300	213.0
330	182.5
360	156.4
390	134.0
420	114.8
450	98.3
480	84.2
510	72.2
540	61.8
570	53.0
600	45.4