EAD 210B HW#2 Thu May 5

Due Thu May 12.
See the Zombie paper by Munz, Hudea, Imad, and Smith.

Variables & IC:

S	number of susceptible people	100
Z	number of zombies	0
R	number of "removed" people: dead but not zombies.	0
k	kill ratio	

Note: the total polulation was reduced from 10^{10} to 100. This is because the nonlinear terms are too strong when the whole world can interact. If only an isolated village is infected, the odds of human survival are greatly improved.

Parameters:

Π	birth rate	0.0001
β	transmission parameter (rate of infection)	0.0055
δ	natural death rate	0.0001
ζ	spontaneous zombification rate of a corpse	0.09
α	rate of zombie termination, e.g., by decapitation	0.0075
Δt	time period between large scale impulsive kill-backs	5

ODE:
For all t other than when $t = n\Delta t$ (i.e., other than during an impulsive attack):

$$\frac{\partial}{\partial t}\begin{pmatrix} S \\ Z \\ R \end{pmatrix} = \begin{pmatrix} \Pi - \beta S Z - \delta S \\ \beta S Z + \zeta R - \alpha S Z \\ \delta S + \cancel{\alpha S Z} - \zeta R \end{pmatrix}$$

and at the impultive attack time: S and R are constant, but

$$Z(n\Delta t + \epsilon) = Z(n\Delta t - \epsilon) - kZ(n\Delta t - \epsilon)$$

in the limit $\epsilon \to 0$, where $n = 1, 2, 3, ...$ is a positive integer.

Note: the $\alpha S Z$ term is omitted here, but was present in the paper. This is the rate of loss of zombies due to decapitation, and a decapitated zombie cannot be reanimated as a zombie. Therefore, that zombie population decline should not enter the resuractable R pool.

Problem: find k so $S/Z = 1$ when $t = 365$.

Note: (1) think of this as a BVP with multiple boundaries, Δt, $2\Delta t$, ... (2) S, R, and Z are integers, but treat them like real numbers. (3) The solution may not exist, or may not be unique. The parameters come more or less from the paper. If no solution exists, try to tweak the parameters so one does.