ENGR 232 Matlab Assignment Week # 3

Three persons (husband, wife and child) infected with Ebola returned to their village, which had no one else infected, at time t=0. The virus is spread through contact between sick and well members of the population. Let *P* be the **proportion** of the population that has contracted the virus. The proportion of the population that has been infected can be expressed by the first order differential equation:

$$\frac{dP}{dt} = k\,P\,(1-P) \qquad P(0) = P_0$$

where the growth constant *k* is 0.04. The village was quarantined, limiting the total population to 15,000. Assume no one enters or leaves the village during the modeling time.

1. Use Euler's method with a time steps of 10, 5 & 1 hours to numerically approximate the system for 500 hours. With each of these time steps approximate how long will it take for half the population to be infected? Print the answers. Plot both solution curves on the same plot.

2. Use second order Runge-Kutta method with a time step of 5 hours to numerically approximate the system for 500 hours. With this method again approximate how long will it take for half the population to be infected? Print the answers. Plot your solution curve on the same plot as above.

3. Solve the system using ode45() with 5 hour time steps by using a function with naming convention **ebola.m**. Plot the solution on the same figure as above. Again, with this method, how long will it take for half the population to be infected? Print the answer.

4. The analytical solution to the system is:

$$P = \frac{e^{kt}}{e^{kt} + 4999}$$

   Estimate the mean square error (MSE) for each of the three numerical methods at the 5-hour time steps.

5. Comment on the solutions of the different simulations above.

Euler's Method:

$$y' = f(t,y)$$
$$t_{n+1} = t_n + h$$
$$y_{n+1} = y_n + hf(t_n, y_n)$$

Second Order Runge-Kutta Method:

$$y' = f(t,y)$$
$$t_{n+1} = t_n + h$$
$$y_{n+1} = y_n + h\,k_{n2}$$
$$k_{n1} = f(t_n, y_n)$$
$$k_{n2} = f\left(t_n + \frac{h}{2},\quad y_n + \frac{h}{2}\,k_{n1}\right)$$

Note: Submit a published pdf file of your script with convention **lastname_initials_lab1.m** The published document must include all functions used. All figures must be annotated (labels, legends, markers, title, etc. Answers to questions asked should be printed as an output.