Homework #3

1. In the DeLeo - Dobson paper, what are some effects the authors mentioned that should be included in their type modeling study?

2. In the Longini, et al paper they mention that there are two extremes in age-specific illness attack rates. What are they and which one is closer to the attack rate they use in their model simulation study?

   Their population of susceptibles is made up of social networks of interconnected groups. Give me some examples of contact groups that make up the population.

3. Capasso and Serio (Math. Biosciences 42, pp 43-61 (1978)) considered a model with emigration of susceptibles. It takes the form

$$\frac{dS}{dt} = -g(I)S - \lambda S$$
$$\frac{dI}{dt} = g(I)S - \gamma I$$
$$\frac{dR}{dt} = \lambda S + \gamma I$$

   where $g(I)$ has the qualitative form
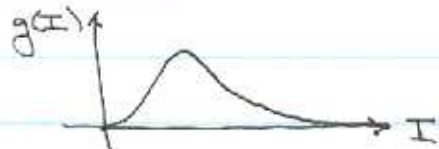
   and is suppose to account for "psychological" effects

   Explain the equations and show an epidemic will always tend to extinction with regard to both infectives and susceptibles.

4. Consider an epidemic outbreak of a lethal disease in which the infectious period and an incubation period of the disease are different. Now we have a sub-population, E, that are incubating the disease, along with the infective sub-population, I. During the epidemic assume the population is constant, say N. If a susceptible can be infected

by someone who is incubating the disease, but less easily than by an infected person, then one SEIR model is

$$\frac{dS}{dt} = -\frac{\beta S}{N}(I + rE) \qquad \frac{dE}{dt} = \frac{\beta S}{N}(I + rE) - bE$$

$$\frac{dI}{dt} = bE - cI \qquad \frac{dR}{dt} = cI.$$

What does each of the parameters β, r, b, c measure? Determine the conditions on the disease-free steady state that will make it unstable. Deduce that the basic reproductive rate $R_0 = (\beta/bc)(b + cr)$.