# M2E03 - INTRODUCTION TO MODELLING ASSIGNMENT 1

DUE:NOON,THURSDAY,SEPTEMBER 29

All the Question should be written in MATLAB and title of the email should be "SOLUTION TO ASSIGNMENT 1"

Submit clear legible matlab programme for the solution at email:manimeh@gmail.com
LATE ASSIGNMENTS WILL RECEIVE A GRADE OF ZERO.

You do not have to answer the questions that are written in **italics**.

1. (a) Evans and Smith (1952) calculated $r$ for the human louse and found it to be approximately 0.1 per day. Start with the equation

   $$N(t) = N(0)e^{rt}$$

   if we know $r, N(0)$ and $N(t)$, how can we find $t$?(Hint: Rearrange the equation to get $t$ in terms of $N(t), N(0)$ and $r$.)

   (b) Starting with 10 lice, how long will it take for an exponentially growing population of lice to reach 10,000? 10,000,000? 10,000,000,000 ? *Does this surprise you?*

   (c) Given any initial population size that is greater than zero, how long will it take for the population to double?

2. Use the MATLAB plot function to draw the Geometric growth over 10 discrete time steps, starting with a population size of 1 and a multiplication rate ($\lambda$) of 2 each time step.

3. A bacterial population has a doubling time of 20 minutes (has a $\lambda$ of 2). Starting with a population of 10 bacteria, what would be the potential population size after 12 hours?

4. An insect population is observed to increase from 6 to 15 individuals over a two-week period. What will be the population size after 10 weeks( from time 0) if the multiplication rate stays the same?

5. A continuously growing population was observed to double in size every three days. Calculate the multiplication rate ($\lambda$) per day and per week.

6. In a population (of an imaginary organism that lives up to 2 years), the average number of offspring that 0-year-olds have the following year is $\frac{1}{2}$, the average number of offspring that 1-year-olds have the following year is 2, and the probability that a 0-year-old survives to age 1 is $\frac{1}{2}$. Death is certain after 2 years.

   (a) Set up a Leslie matrix model for this population and find out the growth rate.

   (b) If the population starts with 1 adult and no juveniles, find the number of juveniles, the number of adults and the total population after 3 years. Do the same if the population starts with one juvenile and no adults. *Who seems to be 'worth more' in terms of future population size - adults or juveniles ?*

   (c) Find the long term growth rate and the stable age distribution.

7. Given the following values of $l_x$ and $m_x$, find $r$ accurate to two decimal places. (Hint: Try different values of $r$ in Euler's equation. If the sum is too large, try a larger value of $r$; if it is too small, try a smaller value of $r$.)

| x | $l_x$ | $m_x$ |
|---|---|---|
| 0 | 1.0 | 0 |
| 1 | 0.6 | 0 |
| 2 | 0.5 | 0 |
| 3 | 0.4 | 3 |
| 4 | 0.3 | 4 |
| 5 | 0 | 0 |

   Compute the stable age distribution $c_x$ and reproductive rate ($R_0$).

8. (**OPTIONAL**) *For a life table, $l_x$ is the fraction of newborn individuals that survive to age $x$, and $S_x$ is the probability of surviving from age $x$ to age $x+1$.*

   *(a) Why is $l_0$ always 1?*

   *(b) Express $l_{x+1}$ in terms of $l_x$ and $S_x$ ?*