

MAT 451 Homework 1. These problems are due on Tuesday, Sept. 3

Exercise 1.1: Show that the solution of $x' = re^{-at}x$, $x(0)=1$ is the same as the solution of $x' = rx - ax \ln x$ with $x(0)=1$.

Exercise 1.2: True or false? Show your work in detail. A single cell of the bacterium *E. coli* would, under ideal circumstances, divide every twenty minutes. ... it can be shown that in a single day, one cell of *E. coli* could produce a super-colony equal in size and weight to the entire planet earth.

Exercise 1.3: Problem 5, page 152.

Exercise 1.4: Assume that a logistic growing fish population is harvested at the rate of C /unit of time, then the population grows according to $dN/dt = rN(1-N/K) - C$. Where would you like to maintain the population size in order to manage for Maximum Sustained Yield (MSY)? Answer the same problem if the fish population is harvested only in a fixed amount of time each unit of time.

Exercise 1.5: Use your favorite program (such as Plotdigitizer <https://plotdigitizer.com/app>) to extract the data set from the bottom panel of Figure 4.1 on page 120. Try to best fit the data set with a solution of a logistic equation using `fminsearch`. The following is a sample MATLAB program.

```
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function estimation    %(x0)
global T M r K
x0=[.2;60];
[min]=fminsearch(@er,x0)
min(1)=r; min(2)=K;
[t,y]=ode23s(@estimat,[0 60],0.1626);
plot(t,y,T,M,'o')
function z=er(x)
global T M r K
tt=0:1:60;
% data points from experiment
T=[21,28,35,42,52]';
M=[3.970266954,10.71652176,22.99810298,38.1305546,29.60611184]';
r=x(1); K=x(2);
y0 = [0.1626]; y = y0;
[t1 y1] = ode23s(@estimat, tt, y0);
z=sum((y1(T)-M).^2); % minimize this.
```

```
function yp = estimat(t,y)
global r K
yp = y;
yp(1) = r*y(1)*(1 - y(1)/K);
```