CS : 215
Signal & Data Communication Laboratory

Experiment: V-B

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Problem

Suppose a system is governed by the differential equation,

$$\frac{dy(t)}{dt} + 5y(t) = 3\frac{dx(t)}{dt} - x(t)$$

Find a closed form expression for the complete system response (both zero-state-response [ZSR] and zero-input-response [ZIR]), given that, initial condition $y(0^-) = 3$ and input $x(t) = \sin(t)u(t)$. Also, find both steady-state response and transient response of the system. You may use "dsolve" function of MATLAB. Further, choose time span judiciously.

Plot ZSR, ZIR, complete response, and transient response due to input.

Theoretical Background

Zero Input Response(ZIR) : The zero input part of the response is the response due to initial conditions alone with no input given to the system.

Zero State Response(ZSR) : The zero state part of the response is the response due to the system input alone (with initial conditions set to zero).

Transient Response : The transient response (also called natural response) of a causal, stable LTI differential system is the homogeneous response, i.e., with the input set to zero(initial value).

Steady State Response : The steady-state response (or forced response) is the particular solution corresponding to a constant or periodic input.

Discusssion

In Order to solve this real life problem, we have mad many assumptions. These are:

- The birds take first four months to migrate from their home to sanctuary.
- The male female ratio at any time of the population is calculated using rand function.
- During mating ,no of chicks produce depends on number of males and females, which is smaller.
- In 5^{th} month, birds mate in random ratios to produce 2 eggs (Male:Female = 1:1 ratio).
- In 6^{th} month, eggs hatch revealing chicks. Half of these chicks die.
- In 7^{th} month, chicks leave to join arriving birds. Population decreases. Here arriving birds refer to birds going t arrive next season.
- In 8^{th} month, 50 % of the surviving population die { excluding } chicks.
- From 9^{th} to 12^{th} month, the sanctuary birds return back to their homes and the sanctuary population again falls to 0.

Methodology

1. Take a set of array containing the original bird population for subsequent years.
2. Calculate the number of birds that successfully made it to sanctuary using the value of a
3. Note the total current Population of the Sanctuary
4. Calculate the no of chicks that are born for the surviving population depending of which is greater, male or female.
5. Calculate the number of chicks who survive using b% and the number of males and females among them.
6. Note the total current Population of the Sanctuary
7. Calculate the number of chicks that left the sanctuary to join arriving population
8. subtract the above number from total population and note down the current total population
9. Calculate the number of deaths and subtract them from total population. Also note down the deaths for subsequent year.
10. Note the total current Population of the Sanctuary
11. Start with step 1 for subsequent year, this time add the number of chicks joining the arriving population to surviving population.
12. We have taken observations for a period of 5 years.

Code

```
clc;
clear all;

flock = [1000,2000,4000,2500, 3200]

a = 0.60;
b = 0.40;
dr = 0.30;
m_ cs = 0;
f_ cs = 0;
p(1,1) = 0;
```

```
for i=1:length(flock)
j = 1;
survived(i) = a*flock(i) + (m_ cs + f_ cs)*b;
r1 = rand(1);
f_ survived = survived(i) * r1;
p(i,j+1) = p(i,j) + survived(i);
j++;
if (r1 <0.5)
m_ cb = f_ survived;
f_ cb = f_ survived;
else
m_ cb = survived(i)-f_ survived;
f_ cb = survived(i)-f_ survived;
endif
r2 = rand(1);
f_ cs = r2 * m_ cb/2;
m_cs= (1-r2) * m_ cb/2;
p(i,j+1) = p(i,j) + (m_ cs + f_ cs);
j++;
ch_ var(i) = (m_ cs + f_ cs)*b;
p(i,j+1) = p(i,j) + (m_ cs + f_ cs)*(1-b);
j++;
d(i) = survived(i) * dr;
p(i,j+1) = p(i,j) - d(i);
p(i+1,1) = 0;
endfor

i = 1:1:length(flock);
```

```
subplot(2,2,1);
bar(p);
xlabel(’Year’);
ylabel(’Bird Population in Sanctuary’);
set(gca, ...
’Box’, ’off’, ...
’TickDir’, ’out’, ...
’FontSize’, 20, ...
’FontName’, ’Calibri’);
lgd = legend(’Month[1-4]’,’Month 5’, ...
’Month 6’, ’Month 7’, ’Month 8’);
set(lgd, ’FontName’, ’Times’, ’FontSize’, 15);

subplot(2,2,2);
bar(p);
xlabel(’Year’);
ylabel(’Bird Population in Sanctuary’);
set(gca, ...
’Box’, ’off’, ...
’TickDir’, ’out’, ...
’FontSize’, 20, ...
’FontName’, ’Calibri’);
lgd = legend(’Month[1-4]’,’Month 5’, ...
’Month 6’, ’Month 7’, ’Month 8’);
set(lgd, ’FontName’, ’Times’, ’FontSize’, 15);

subplot(2,2,3);
bar(i,d,0.6, ’r’);
```

```
xlabel('Year');
ylabel('Number of Bird Deaths');
set(gca, ...
'Box', 'off', ...
'TickDir', 'out', ...
'FontSize', 20, ...
'FontName', 'Calibri');

subplot(2,2,4);
bar(i,ch_ var,0.6, 'b');
xlabel('Year');
ylabel('Chicks leaving to Join Arriving birds');
set(gca, ...
'Box', 'off', ...
'TickDir', 'out', ...
'FontSize', 20, ...
'FontName', 'Calibri');
```

Graphs And Analysis

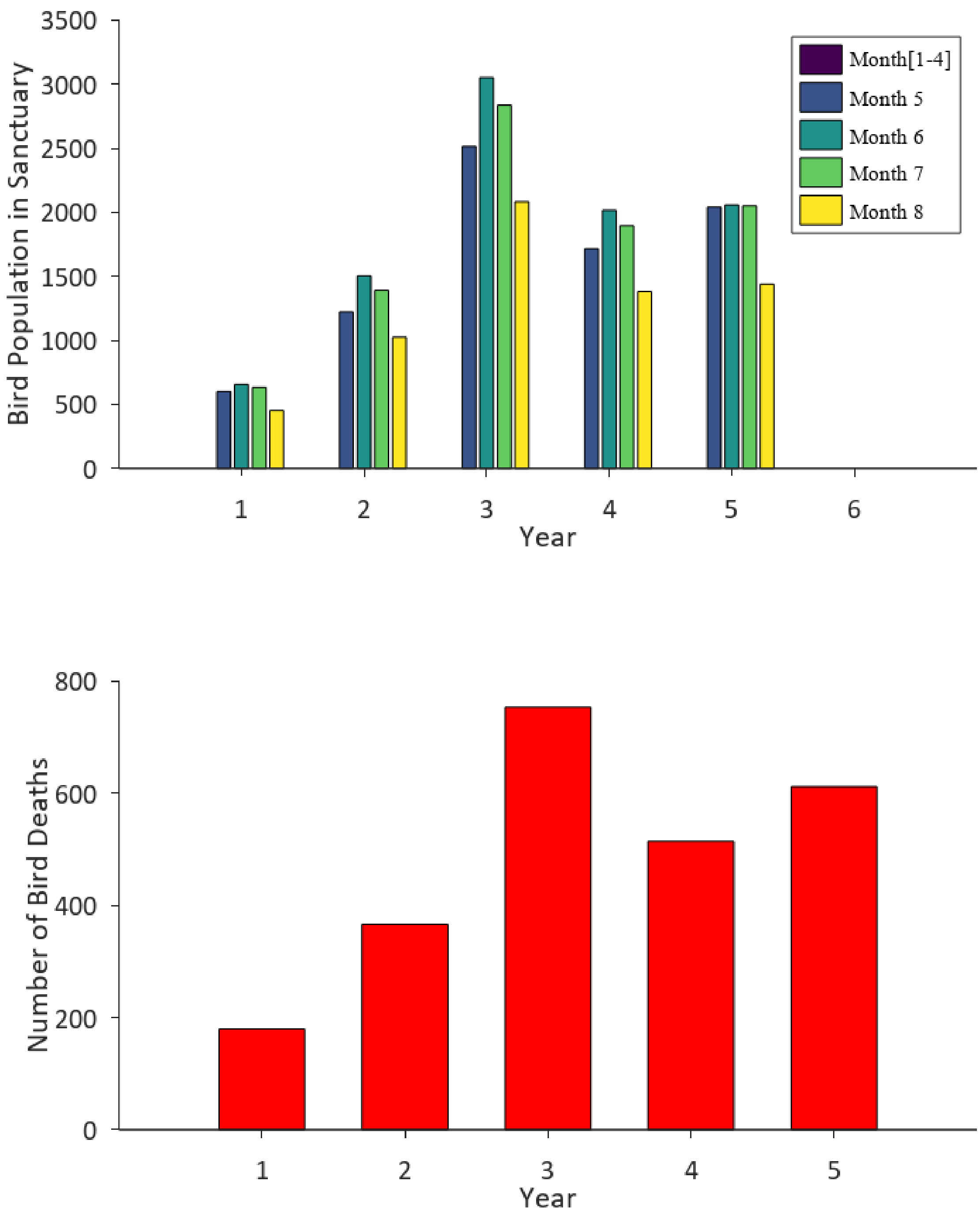

Figure 1: Variation of Bird Population with Number of Deaths

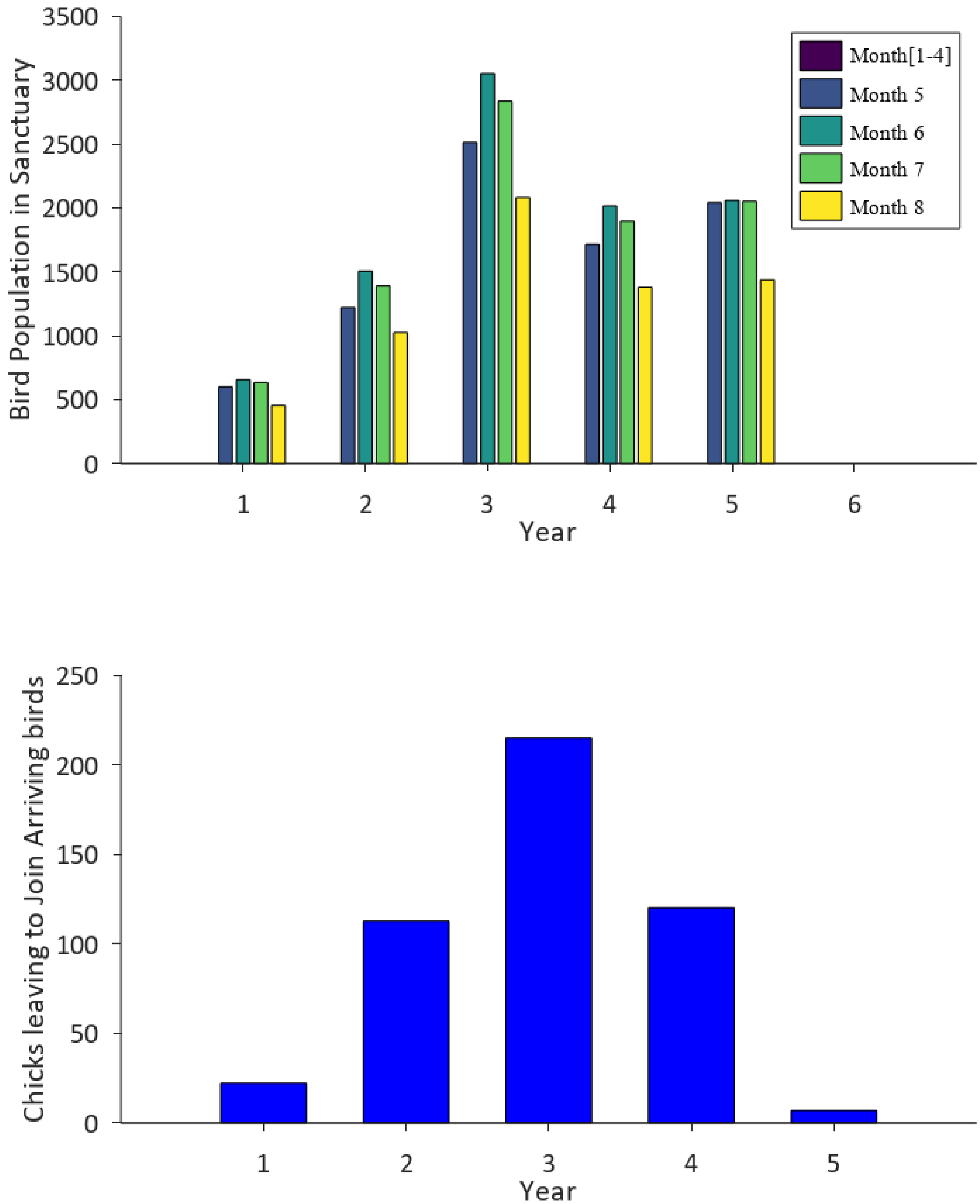

Figure 2: Variation of Bird Population with Number of Chicks leaving to join Arriving Birds

Input Data Description

We have assumed,

$$a\% = 0.60$$

$$b\% = 0.40$$

$$c\% = dr\ (die\ rate) = 0.30$$

Note that these values can be changed as per the user requirements.

Result

We have successfully obtained:

1. Variation of Bird Population with their deaths
2. Variation of Bird Population with Number of chicks leaving to join arriving birds

for a period of 5 years.