Annex A: Sourcecode for the Program implementing Fourth Order Runga-Kutta method

A.1 SOURCECODE OF FIGURE 1

```
%func.m
%Author: Jitendra Shrestha
%


function diffy = func(t,y)
K = 10000;                                  %Carrying Capacity Population
T = 1000;                                    %Minimum Threshold Population
e = 4;
r = 0.04;                                    %Population Growth Rate
E = 0.00;                                    %Fishing Effort Rate
if y/T <= e
    diffy = -r*y*(1-y/T)*(1-y/K)-E*y;            %Equation (6.2 & 6.3)
else diffy = r*y*1*(1-y/K)-E*y;                  %Equation (6.2 & 6.3)
end

% rungekutta1.m
%Fourth Order Runge-Kutta Method
%Author: Jitendra Shrestha
%
clc
clear all

t0 =0;                                      %Initial time
t1 =520;                                    %Final time - 520 weeks = approx. 10
years
h = 1;                                      %Step size - 1 week
n = (t1-t0)/h+1;                            %Number of Steps
t = zeros(n);                               %Time Calibration
y = zeros(n);                               %Vector Initialization

t(1) = t0;                                  %Initial time
Pop = [12000; 10000; 7000; 5500; 4000; 1000; 500];      %Initial Population
Vector
for j =1:size(Pop)
y(1) = Pop(j);                              %Population Initialization
    for i = 1:n-1
        k1 = h*func(t(i),y(i));                 % Runge-Kutta Method
        k2 = h*func(t(i)+0.5*h,y(i)+0.5*k1);
        k3 = h*func(t(i)+0.5*h,y(i)+0.5*k2);
        k4 = h*func(t(i)+h,y(i)+k3);

        y(i+1) = y(i)+(k1+2*k2+2*k3+k4)/6;
        t(i+1) = t(i)+h;
        fprintf('\n%10.2f%20.0f',t(i),y(i));
    end                %Inner for loop

    figure (1)         %Hold the figure to juxtapose various graphs
    hold on
    if          (j==1);plot (t,y,'b')
```

```
        elseif (j==2);plot (t,y,'c')
        elseif (j==3);plot (t,y,'g')
        elseif (j==4);plot (t,y,'k')
        elseif (j==5);plot (t,y,'m')
        elseif (j==6);plot (t,y,'k')
        elseif (j==7);plot (t,y,'r')
    end             %If Loop

end             %Inner for loop

%FOLLOWING CODE INSERTS VARIOUS TEXT ON THE GRAPH
text(300,11000,'K=10000,T=1000,r=0.04');
title('Carp Population Growth Model with Eq.(5)');
xlabel('Time in Weeks');
ylabel('Fish population density per mile');
```

A.2 SOURCECODE OF FIGURE 3

```
%func.m
%Author: Jitendra Shrestha

function diffy = func(t,y)
K = 10000;                                  %Carrying Capacity Population
T = 1000;                                   %Minimum Threshold Population
e = K/T;                                    %Function Behavior Constant
r = 0.04;                                   %Population Growth Rate
E = 0.0737;                                 %Fishing Effort Rate
if y/T <= e
    diffy = -r*y*(1-y/T)*(1-y/K)-E*y;          %Equation (6.2 & 6.3)
else diffy = r*y*1*(1-y/K)-E*y;                %Equation (6.2 & 6.3)
end


%rungekutta1.m
%Fourth Order Runge-Kutta Method
%Author: Jitendra Shrestha
%
clc
clear all

t0 =0;                                  %Initial time
t1 =520;                                %Final time - 520 weeks = approx. 10
years
h = 1;                                  %Step size - 1 week
n = (t1-t0)/h+1;                        %Number of Steps
t = zeros(n);                           %Time Calibration
y = zeros(n);                           %Vector Initialization

t(1) = t0;                              %Initial time
Pop = [12000; 10000; 7000; 5500; 4000; 1000; 500];      %Initial Population
Vector

for j =1:size(Pop)
y(1) = Pop(j);                          %Population Initialization
```

```
    for i = 1:n-1
        k1 = h*func(t(i),y(i));          % Runge-Kutta Method
        k2 = h*func(t(i)+0.5*h,y(i)+0.5*k1);
        k3 = h*func(t(i)+0.5*h,y(i)+0.5*k2);
        k4 = h*func(t(i)+h,y(i)+k3);

        y(i+1) = y(i)+(k1+2*k2+2*k3+k4)/6;
        t(i+1) = t(i)+h;
        %fprintf('\n%10.2f%20.0f',t(i),y(i));
    end                %Inner for loop

    figure (1)         %Hold the figure to juxtapose various graphs
    hold on
    if           (j==1);plot (t,y,'b')
        elseif (j==2);plot (t,y,'c')
        elseif (j==3);plot (t,y,'g')
        elseif (j==4);plot (t,y,'k')
        elseif (j==5);plot (t,y,'m')
        elseif (j==6);plot (t,y,'k')
        elseif (j==7);plot (t,y,'r')
    end               %If Loop

end             %Inner for loop

%FOLLOWING CODE INSERTS VARIOUS TEXT ON THE GRAPH
text(250,11000,'K=10000,T=1000,r=0.04,E=0.0737');
title('Carp Population Growth Model with Eq.(6.2)');
xlabel('Time in Weeks');
ylabel('Fish population density per mile');
```

Sourcecode for other figures require slight variation in the input parameter in the code above.