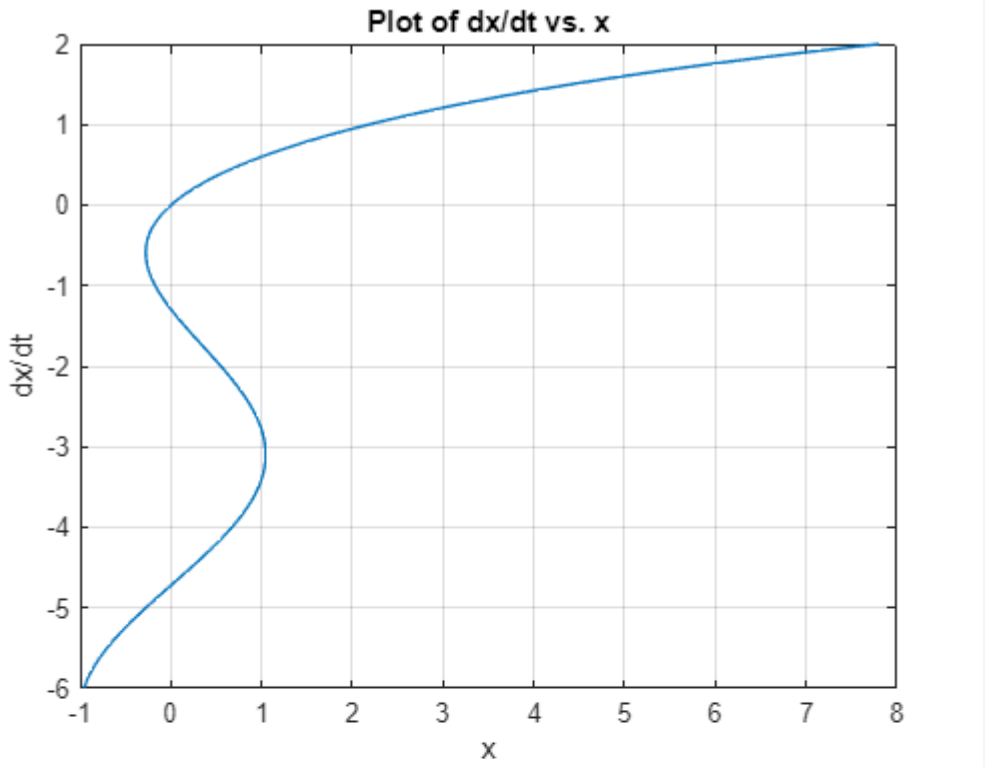
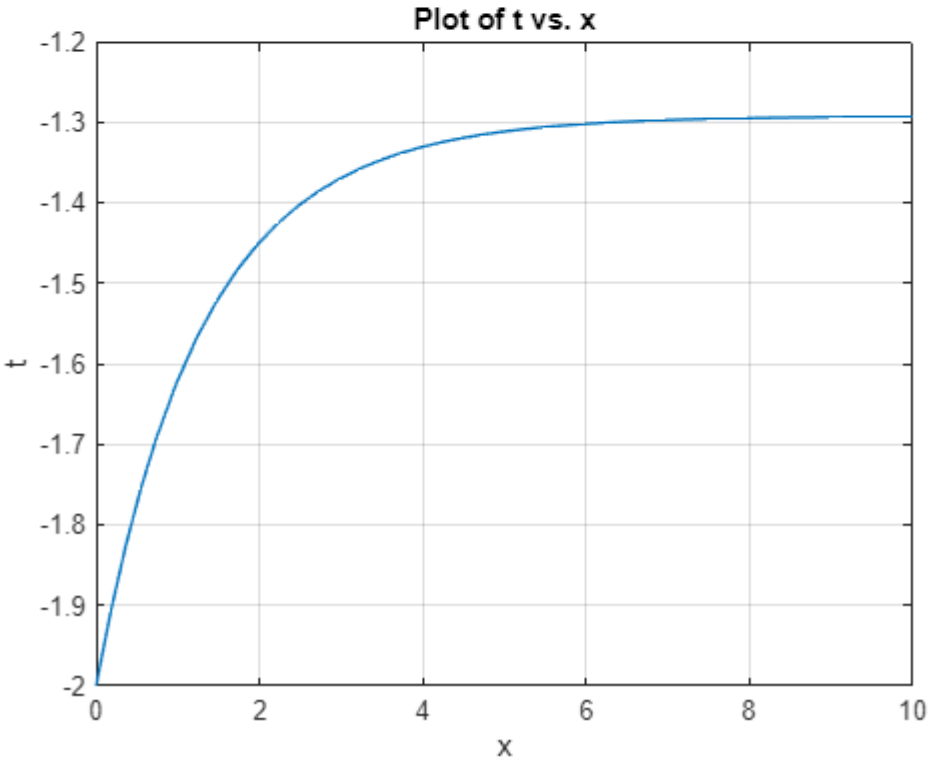
ODE – 001

```
clear

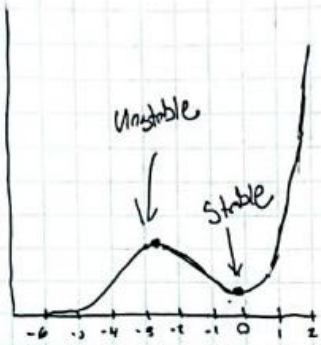
clc
close all
%Start Work
x = linspace (-6,2,100);
dxdt = exp(x) - cos(x);
% Plot
plot(dxdt,x);
xlabel('x');
ylabel('dx/dt');
title('Plot of dx/dt vs. x');
grid on;
%Ode 45
x0 = -2;
odefun = @(t ,x) exp(x) - cos(x);
timespan = [0 , 10];
[t1 , x1] = ode45(odefun,timespan,x0);
plot(t1,x1)
xlabel ('x')
ylabel ('t')
title ("Plot of t vs. x")
grid on
```





Handwritten parts b ,c and f below

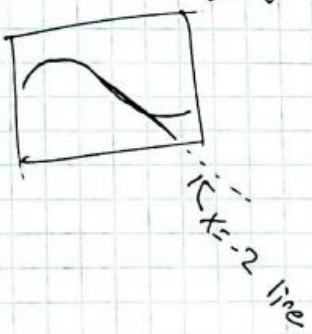
b)



c)

Starting @ $x = -2$ the expected ~~sol~~ solution is ≈ 0.8 @ $x = -0.2$ which is the stable fixed point

graph snapshot



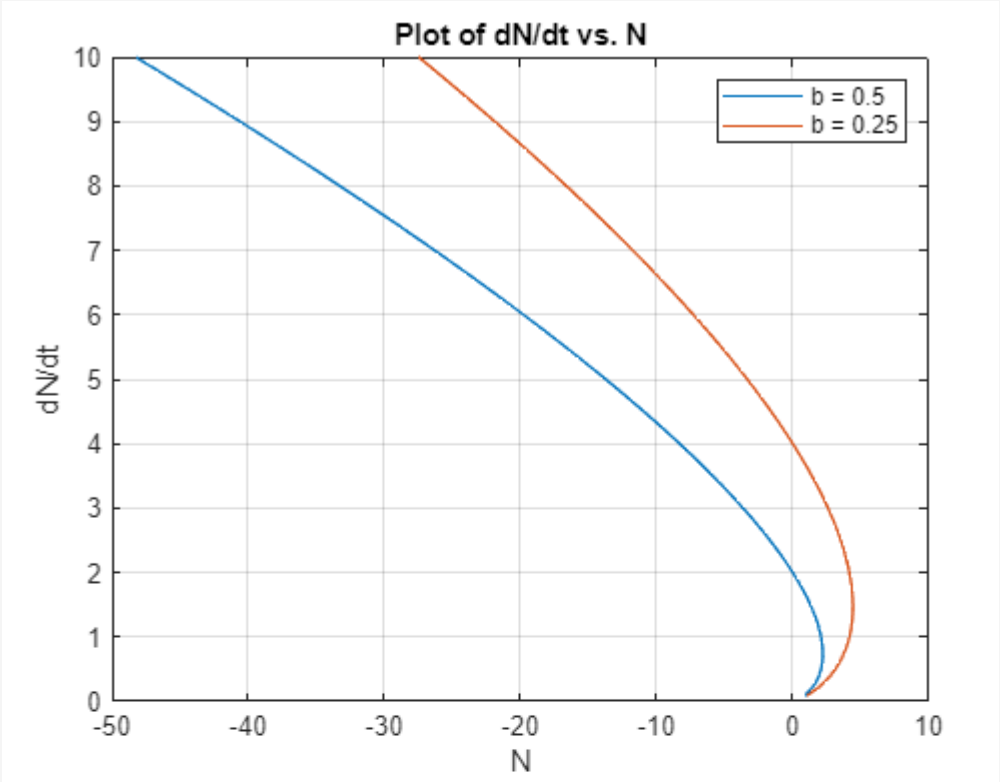
f~~d~~) Parts c & d (w/ graph from e) show the same conclusion, that there is a stable equilibrium ~~state~~ solution near $x = -1.3$ to -1.2. This is represented by a dip in the dt/x graph and an ~~as~~ asymptote in the t/x graph.

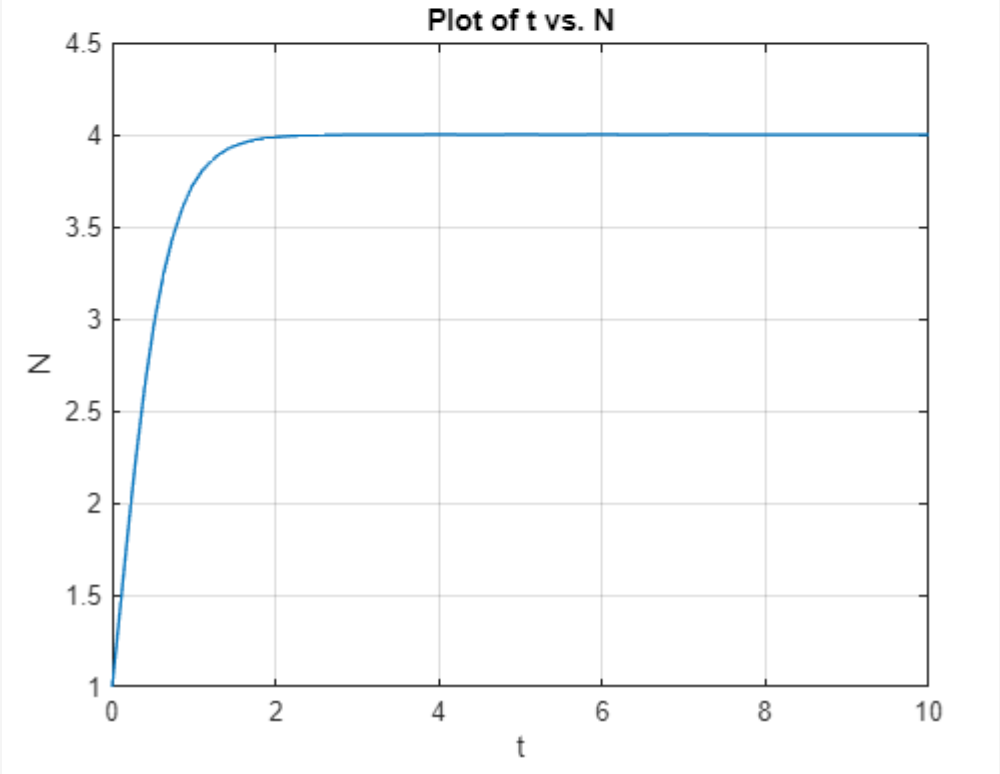
ODE – 002

```
clear

clc
close all
```

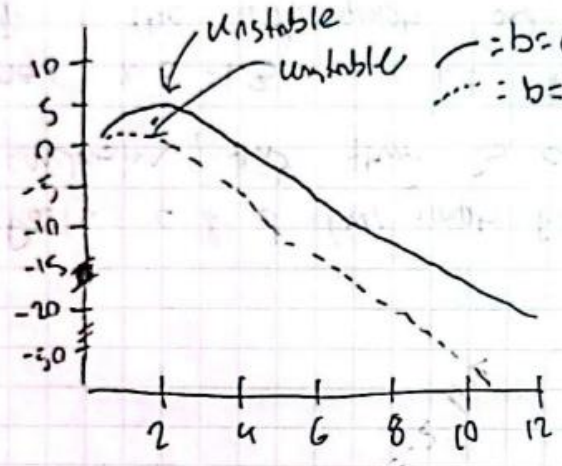
```
%Start Work
N = linspace(0,10,100);
a = 3;
b = [0.5 0.25];
dNdt(1,:) = -a*N.*log(b(1,1)*N);
dNdt(2,:) =-a*N.*log(b(1,2)*N);
plot(dNdt,N)
xlabel ('N')
ylabel ('dN/dt')
title ("Plot of dN/dt vs. N")
legend('b = 0.5','b = 0.25')
grid on
%ode Stuff
odefun1 = @(t, N) -a * N * log(b(1,2) * N);
N0 = 1;
timespan = [0 , 10];
[t1,N1] = ode45(odefun1,timespan,N0);
plot(t1,N1)
xlabel ('t')
ylabel ('N')
title ("Plot of t vs. N")
grid on
```



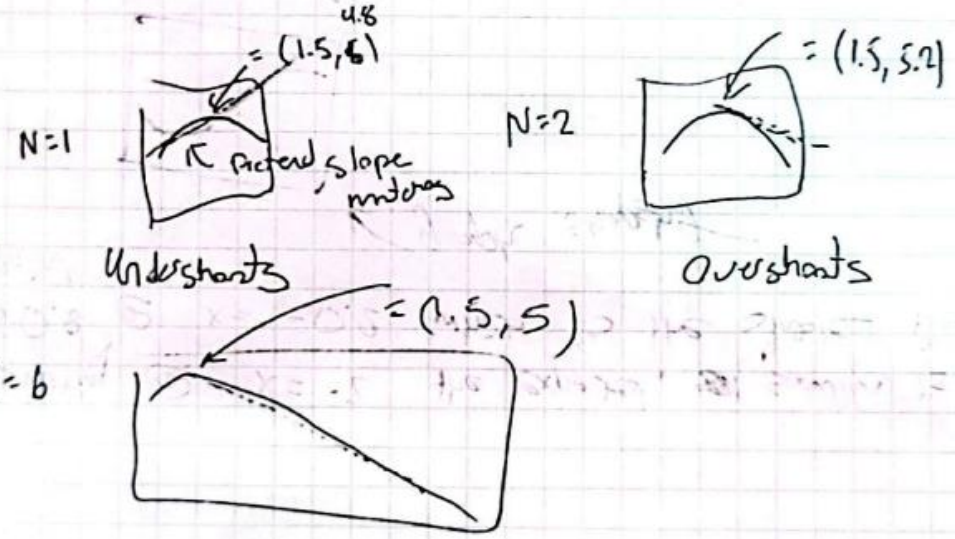


Written work for b , c and f below

b)

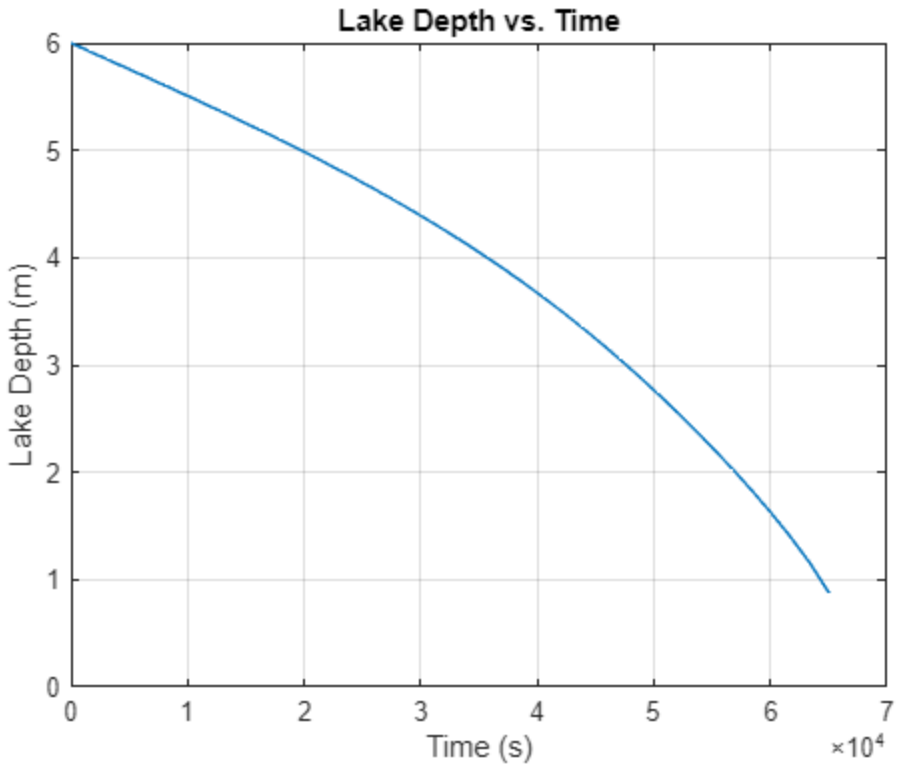


c)



f) Parts seem to suggest different solutions with the visual analysis suggesting $N = 1.5 \Rightarrow N = 2$ being the solution and ode45 suggesting $N = 4$

```
% table data
h_data = [6 5 4 3 2 1 0];
A_data = [11700 9700 6700 4500 3200 1800 0];
% Initialize
R2 = 0;
degree = 1;
while R2 < 0.9995
    p = polyfit(h_data, A_data, degree);
    A_fit = polyval(p, h_data);
    SS_res = sum((A_data - A_fit).^2);
    SS_tot = sum((A_data - mean(A_data)).^2);
    R2 = 1 - SS_res / SS_tot;
    degree = degree + 1;
end
% ode stuff
g = 9.81;
d = 0.25;
e = 1;
odefun = @(t, h) (-1 ./ polyval(p, h)) .* (pi * d^2 * sqrt(2 * g * (h + e)) / 4);
h0 = 6;
timespan = [0, 65000];
hcrit = 2.5;
[time, depthlake] = ode45(odefun, timespan, h0);
% Plot results
plot(time, depthlake);
xlabel('Time (s)');
ylabel('Lake Depth (m)');
title('Lake Depth vs. Time');
grid on;
%h crit
time_at_hcrit = interp1(depthlake, time, hcrit, 'linear', NaN);
fprintf('Answer for part d below:\nTime for lake depth to reach %g m= %g s\n',
hcrit, time_at_hcrit);
```




```
Answer for part d below:
Time for lake depth to reach 2.5 m= 52554.3 s
```