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%Math 246
%Section 0423
%TA: Thien Ngo
%Matlab Project C: Chp 8-10, #4,7,14,15
%03/05/18
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%Problem 4:
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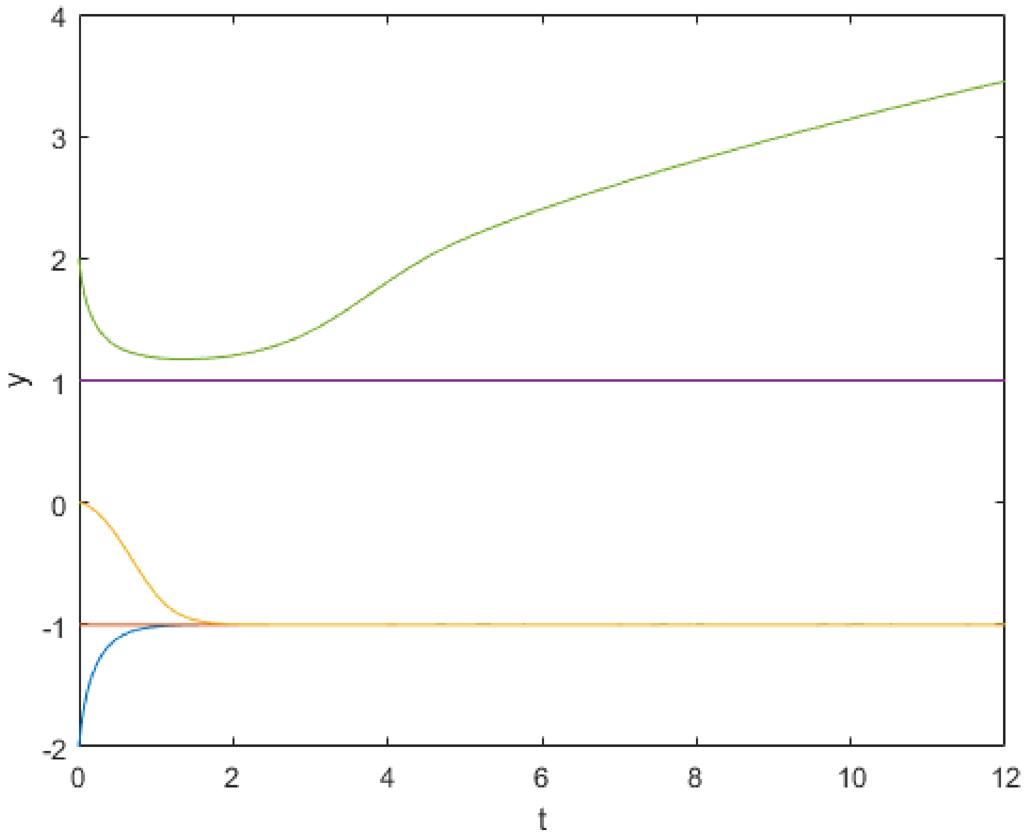
%Part a:
f=@(t,y)(y-sqrt(t)).*(1-y^2);
[t1,y1]=ode45(f,[0,12],-2);
[t2,y2]=ode45(f,[0,12],-1);
[t3,y3]=ode45(f,[0,12],0);
[t4,y4]=ode45(f,[0,12],1);
[t5,y5]=ode45(f,[0,12],2);
figure
plot(t1,y1)
hold on
plot(t2,y2)
plot(t3,y3)
plot(t4,y4)
plot(t5,y5)
hold off
xlabel 't'
ylabel 'y'
```

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%Part b:
%When b<-1, the solution is increasing between t=0 and t=2
%and the limiting behavior is approaching -1.
%When b=-1, the solution is stable at -1. y=-1 is a stationary point.
%When -1<b<1, the solution is decreasing between t=0 and t=2
%and the limiting behavior is approaching -1.
%When b=1, the solution is stable at 1. y=1 is a stationary point as well.
%When b>1, the solution is decreasing between t=0 and t=2, and then from
%t=2 to t=infinity, the solution is increasing and approaches infinity.
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%Part c:
t=0:0.1:12;
y=sqrt(t);
[t6,y6]=ode45(f,[0,12],3);
[t7,y7]=ode45(f,[0,12],4);
[t8,y8]=ode45(f,[0,12],5);
figure
plot(t,y,'--')
hold on
plot(t6,y6)
plot(t7,y7)
plot(t8,y8)
hold off
xlabel 't'
ylabel 'y'
%The solution curves (solid lines) are asymptotic to the parabola (dashed
%lines).
```

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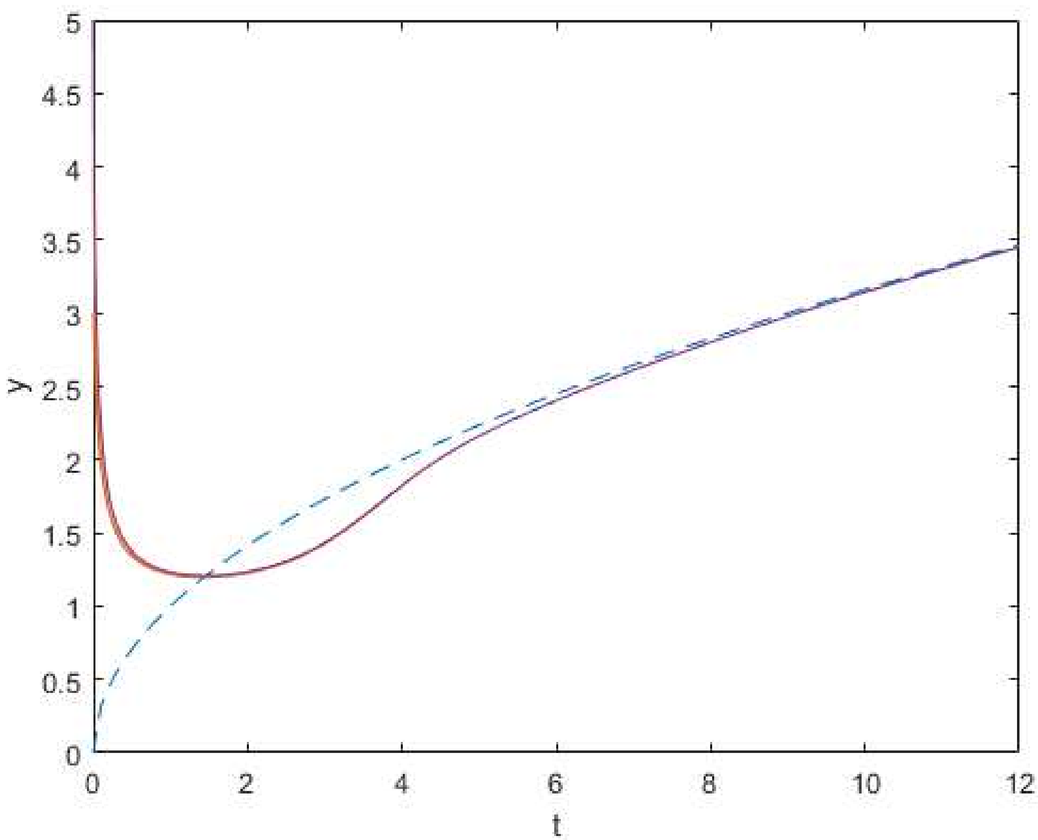
%This is plausible because when you substitute the y-value into the
%differential equation, you get 0 for the derivative, which makes it a
%critical point. This makes it a stationary solution and b will always be
%approaching it.
```

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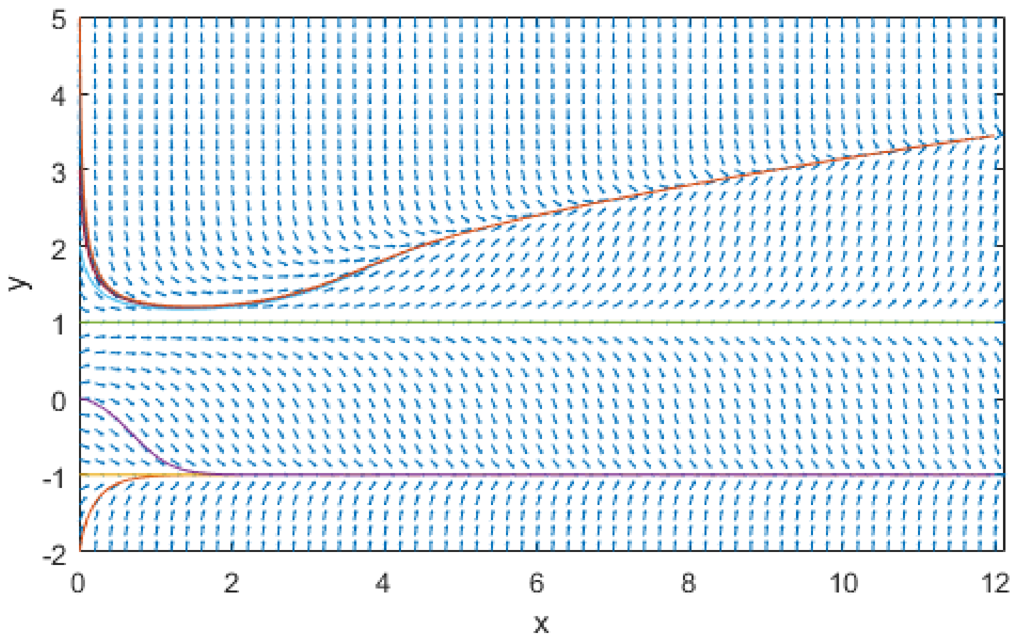
%Part d:
[T,Y]=meshgrid(0:0.2:12, -2:0.2:5);
S=(Y-sqrt(T)).*(1-Y.^2);
L=sqrt(1+S.^2);
figure
quiver(T,Y,1./L,S./L,0.5), axis equal tight
hold on
plot(t1,y1)
plot(t2,y2)
plot(t3,y3)
plot(t4,y4)
plot(t5,y5)
plot(t6,y6)
plot(t7,y7)
plot(t8,y8)
hold off
xlabel 'x'
ylabel 'y'
```

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%Problem 7:
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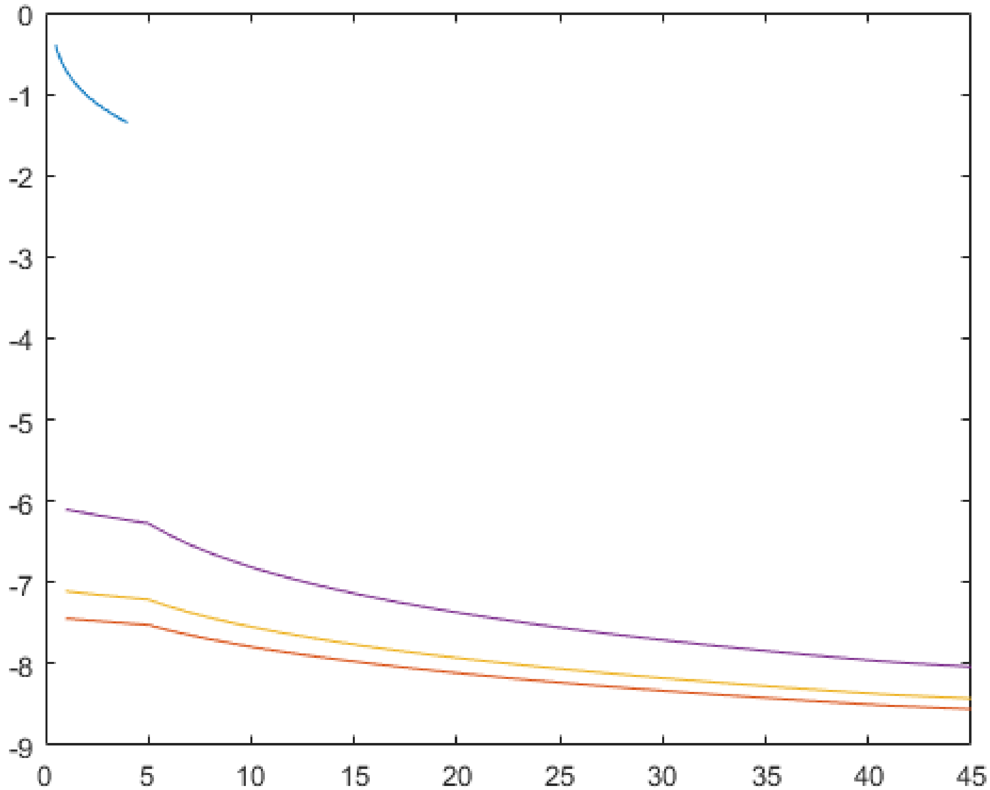
%Part a:
f = @(t,y)-exp(y)/(t*exp(y)-sin(y));
[t, y] = ode45(f,[.5,4],-2/5);
plot(t,y)
hold on
%Part b:
dsolve('Dy = (-exp(y))/(t*exp(y)-sin(y))','y(2)=1.5','t')
plot(cos(y) + 1*exp(y)- cos(3/2) - 2*exp(3/2))
plot(cos(y) + 1.5*exp(y)- cos(3/2) - 2*exp(3/2))
plot(cos(y) + 3*exp(y)- cos(3/2) - 2*exp(3/2))
hold off
%The values of the actual solution are much lower than the vlaues of the
%numerical solution
```

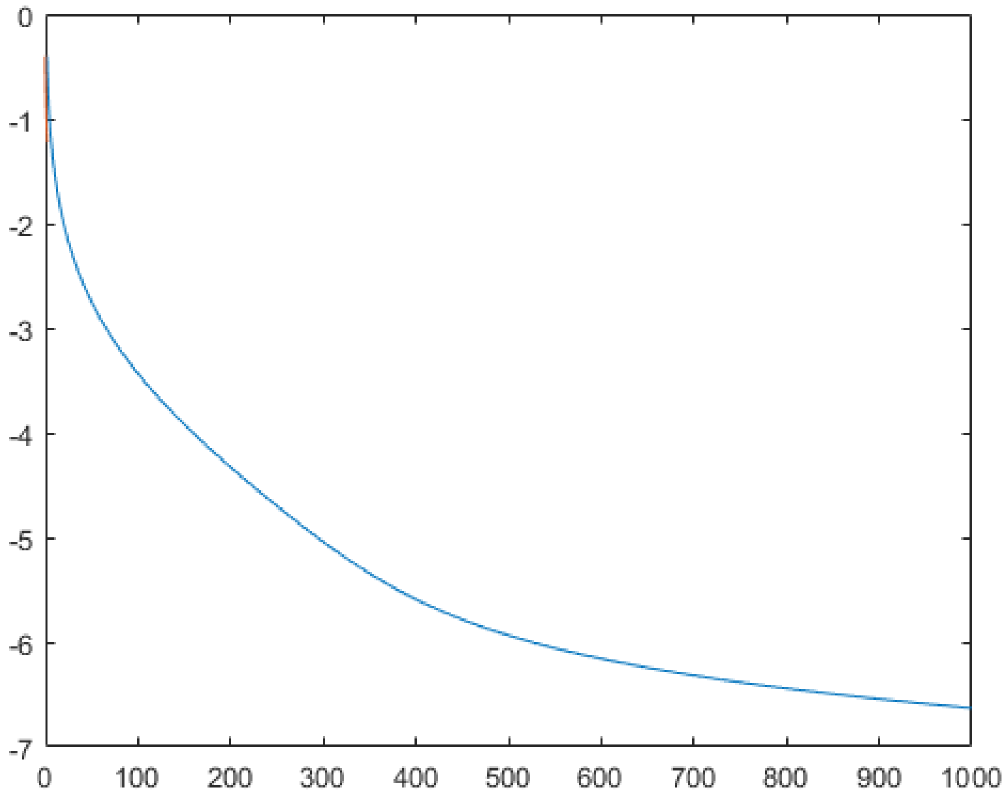
```
Warning: Unable to find explicit solution. Returning implicit solution instead.

ans =

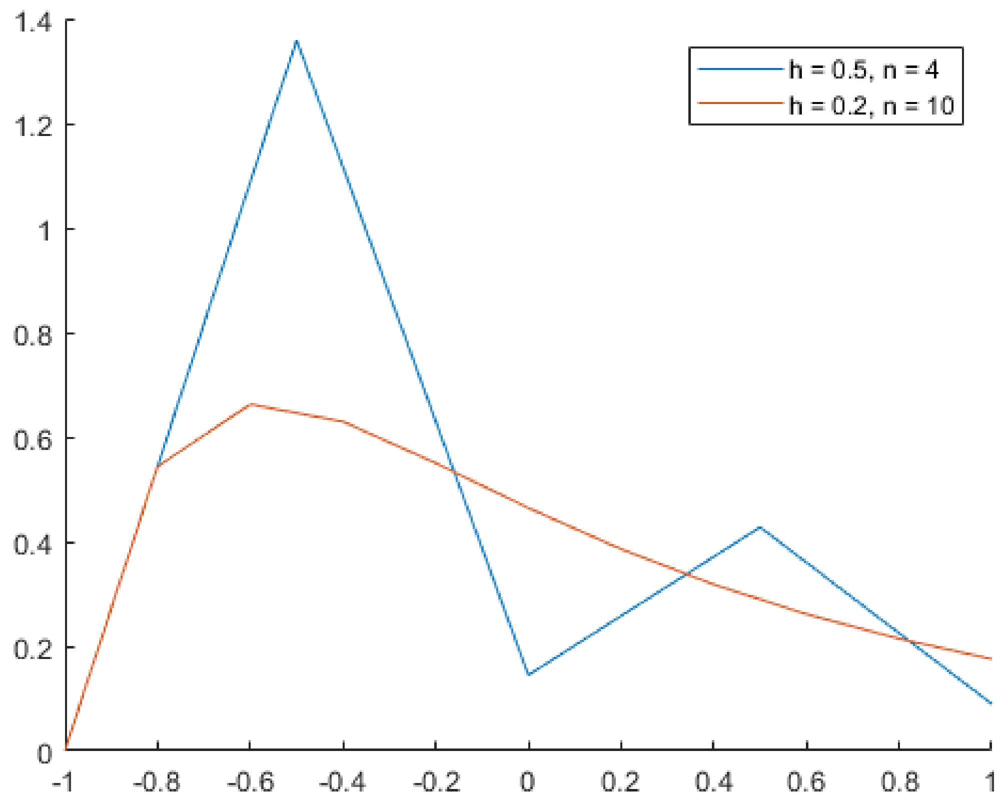
solve(cos(y) + t*exp(y) == cos(3/2) + 2*exp(3/2), y)
```



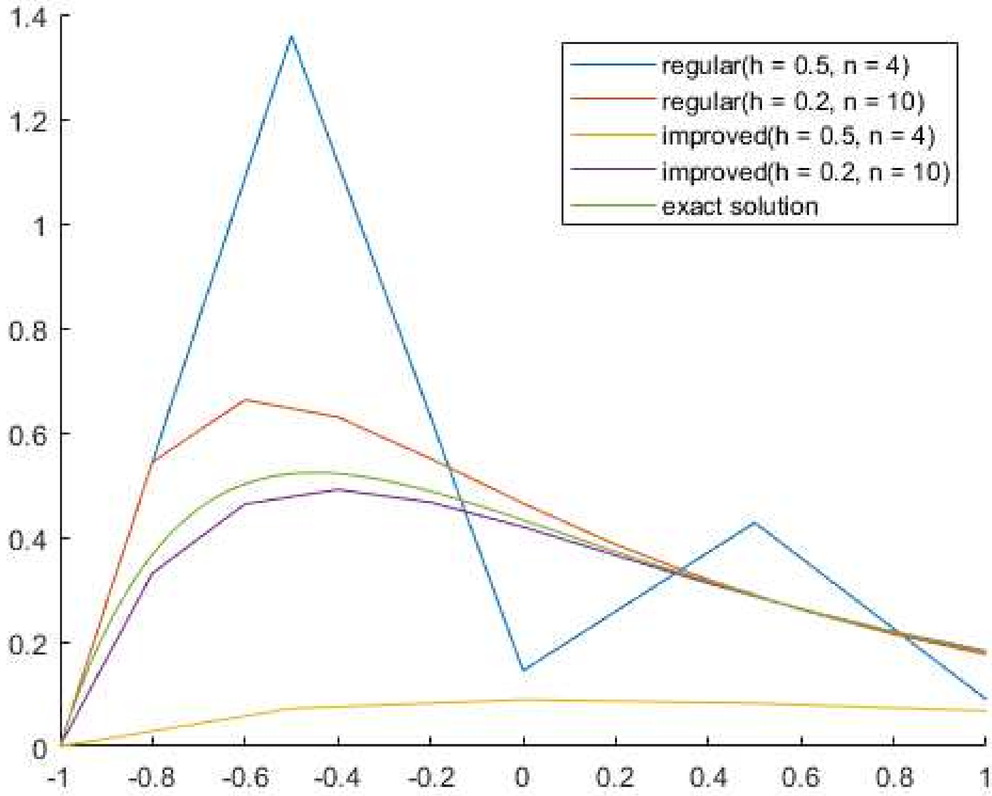

```
%Part c:
f = @(t,y)-exp(y)/(t*exp(y)-sin(y));
[t, y] = ode45(f,[2,1000],-2/5);
plot(t,y)
%As t approaches infinity, y decreases
hold on
[t, y] = ode45(f,[.0001,2],-2/5);
plot(t,y)
hold off
%As t approaches zero from the right, y increases
```



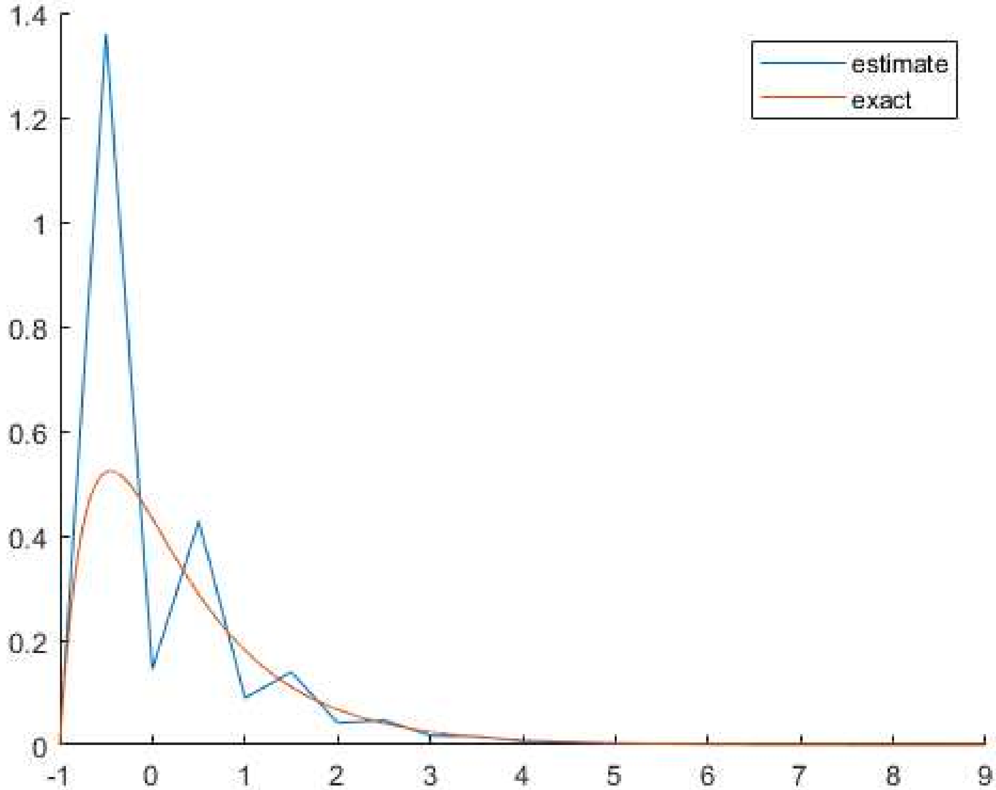

```
%Problem 14:
%Part a:
figure; hold on
f = @(t, y) exp(-t) - 3*y;
[t_1 y_1] = myeuler(f, -1, 0, 1, 4);
p1 = plot(t_1, y_1);
g1 = "h = 0.5, n = 4";
[t_2 y_2] = myeuler(f, -1, 0, 1, 10);
p2 = plot(t_2, y_2);
g2 = "h = 0.2, n = 10";
legend([p1; p2], [g1; g2]);
hold off
```




```
%Part b:
figure; hold on
f = @(t, y) exp(-t) - 3*y;
[t_1 y_1] = myeuler(f, -1, 0, 1, 4);
p1 = plot(t_1, y_1);
g1 = "regular(h = 0.5, n = 4)";
[t_2 y_2] = myeuler(f, -1, 0, 1, 10);
p2 = plot(t_2, y_2);
g2 = "regular(h = 0.2, n = 10)";
[t_3 y_3] = improved(f, -1, 0, 1, 4);
p3 = plot(t_3, y_3);
g3 = "improved(h = 0.5, n = 4)";
[t_4 y_4] = improved(f, -1, 0, 1, 10);
p4 = plot(t_4, y_4);
g4 = "improved(h = 0.2, n = 10)";
t_5 = -1:.001:1;
p5 = plot(t_5, ((exp(2+2*t_5)-1)./(2*exp(2+3*t_5))));
g5 = "exact solution";
legend([p1; p2; p3; p4; p5], [g1; g2; g3; g4; g5]);
hold off
```




```
%Part c:
figure; hold on
f = @(t, y) exp(-t) - 3*y;
[t_6 y_6] = myeuler(f, -1, 0, 9, 20);
p6 = plot(t_6, y_6);
g6 = "estimate";
t_7 = -1:.001:9;
p7 = plot(t_7, ((exp(2+2*t_7)-1)./(2*exp(2+3*t_7))));
g7 = "exact";
legend([p6; p7], [g6; g7]);
hold off
```

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%Problem 15:
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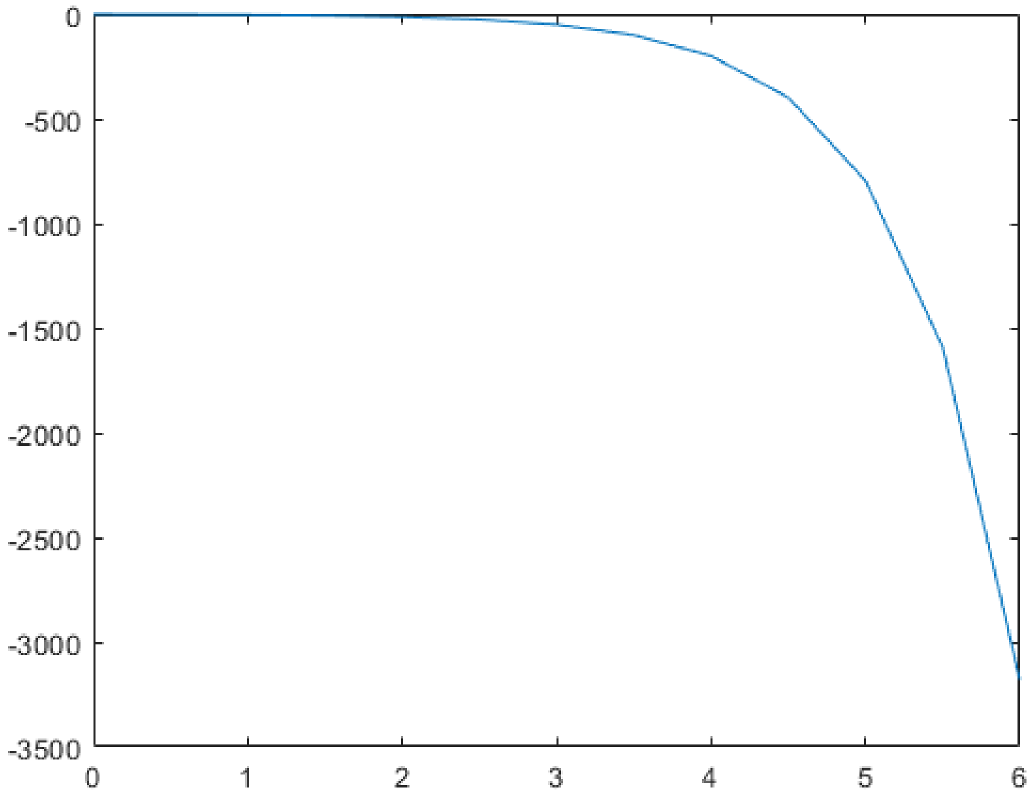
%Part a:
f = @(t,y) 2*y-cos(t);
[t, y] = myeuler(f,0,-2/5,6,12);
plot(t,y)
%As t increases, y appears to be decreasing
```




```
%Part b:
f = @(t,y) 2*y-cos(t);
[t, y] = myeuler(f,0,-2/5,6,12);
hold on
plot(t,y)
[t, y] = myeuler(f,-1,0,6,30);
plot(t,y)
[t, y] = myeuler(f,-1,0,6,60);
plot(t,y)
%The approximate solutions are getting more negative as the step size
%changes. You can make a prediction that the long-term behavior of the
%solution is decreasing.
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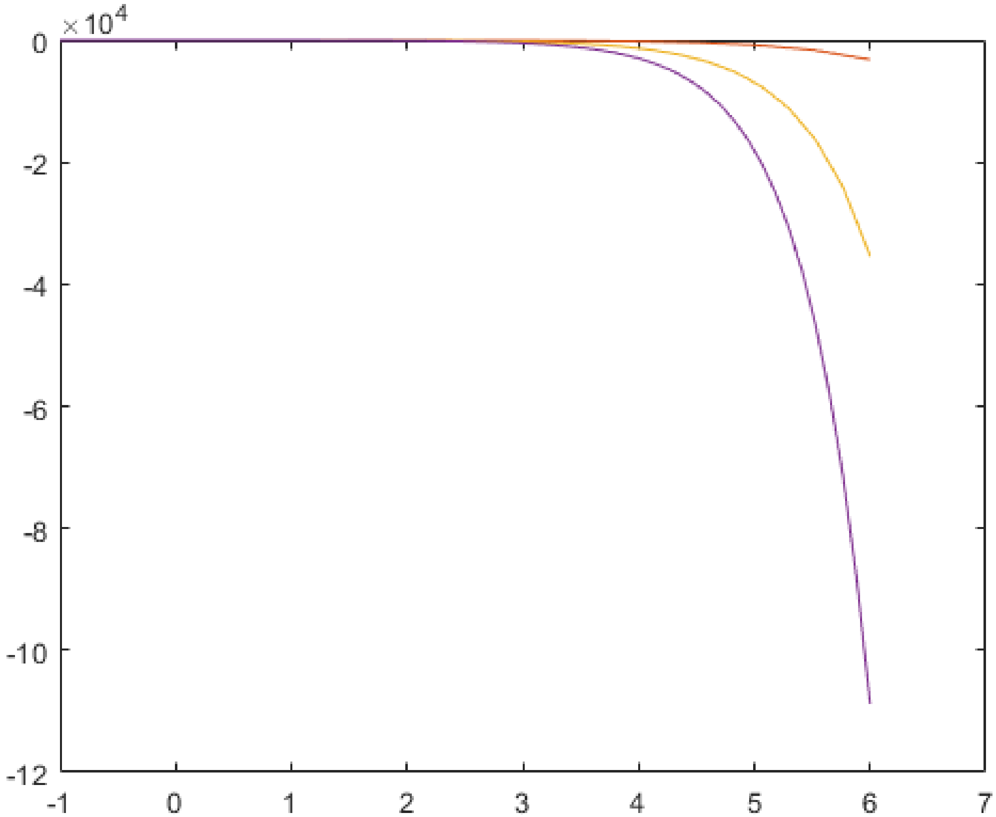
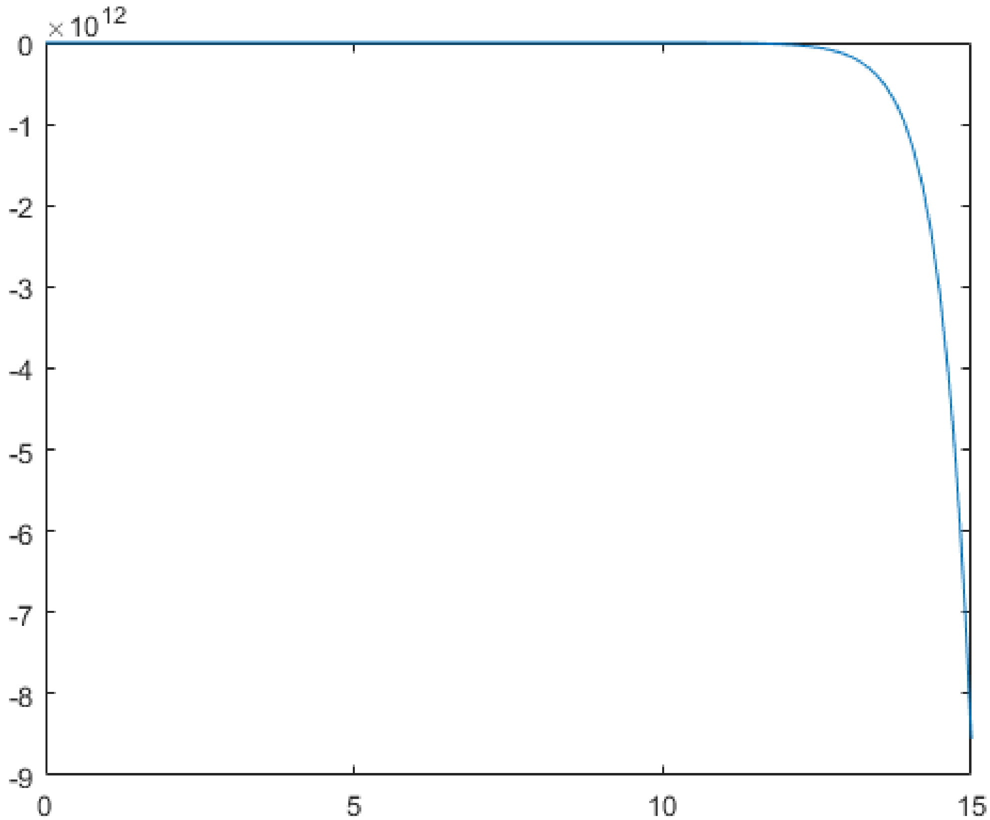



```
%Part c:
f = @(t,y) 2*y-cos(t);
[t, y] = myeuler(f,0,-2/5,6,12);
hold on
plot(t,y)
[t, y] = myeuler(f,-1,0,6,30);
plot(t,y)
[t, y] = myeuler(f,-1,0,6,60);
plot(t,y)
[t, y] = ode45(f,[0,6],-2/5);
plot(t,y)
hold off
clf
%As t increases, y appears to be decreasing
[t, y] = ode45(f,[0,15],-2/5);
plot(t,y)
%Again, as t increases, y appears to be decreasing
```




```
%Part d:
dsolve('Dy = 2*y + cos(t)','y(0)=-2/5','t')
%This shows the the stabilty of the exact solution as t increases with
%time, where y is decreasing for all values of t, as also shown in parts
%a-c
```

```
ans =

-(5^(1/2)*cos(t + atan(1/2)))/5
```

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