MAT 330: Differential Equations

Module Two Template

Complete this template by replacing the bracketed text with the relevant information.

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[5/15/25]

Introduction to dsolve()

Introduction:

MATLAB has several different functions that you can use to solve differential equations. You can use the function dsolve() to solve symbolically defined differential equations.

In this MATLAB assignment, you'll learn how to define and solve symbolic differential equations using the dsolve() function.

Review the code and comments provided in the "Examples" section below, and then use this information to complete the problems listed in the "Problems" section.

Make sure to run your code so all relevant computations/results are displayed, delete the Introduction and Examples sections, and then export your work as a PDF file for submission. Your submission needs to contain only the problems that you completed.

Examples:

```
% Example 1 Code
% This example solves the differential equation y' = 2t^2 + 3t - 2 and
% plots the family of solutions for different values of the constant C1.

%define the function of interest
syms y(t) t;

%compute derivatives of y(t) with respect to t using diff() function
Dy = diff(y(t));

%define the differential equation
%Note: The right side involves symbols so the == sign is used for equality
%between symbolic quantities
```

```
%
%On the left side we have the symbol "ode" which is the entire differential
%equation. Its best to let this print to the screen to verify it has been
%defined correctly.
ode = Dy == 2*t^2 + 3*t - 2
```

ode =

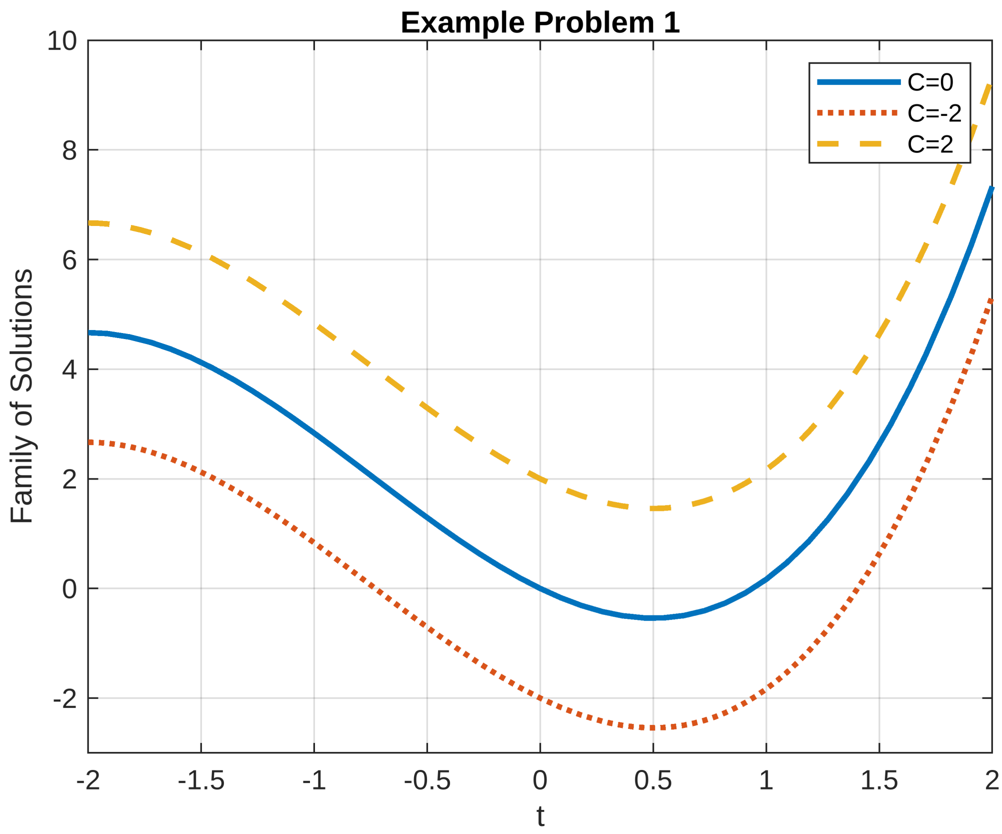
$$\frac{\partial}{\partial t}\ y(t) = 2\,t^2 + 3\,t - 2$$

```
%solve the differential equation using dsolve()
ySoln(t) = dsolve(ode)
```

ySoln(t) =

$$C_1 + \frac{t\ (4\,t^2 + 9\,t - 12)}{6}$$

```
%plot family of solutions for different values of C
C = 0;
ySoln1 = C + t*(4*t^2 + 9*t - 12)/6;
C = -2;
ySoln2 = C + t*(4*t^2 + 9*t - 12)/6;
C = 2;
ySoln3 = C + t*(4*t^2 + 9*t - 12)/6;

figure;
fplot(ySoln1,[-2 2],'-','linewidth',2);
hold on;
fplot(ySoln2,[-2 2],':','linewidth',2);
fplot(ySoln3,[-2 2],'--','linewidth',2);
xlabel('t');
ylabel('Family of Solutions');
title('Example Problem 1');
grid on;
ylim([-3 10]);
legend('C=0','C=-2','C=2');
```




```
% Example 2 Code
% This example solves the differential equation y'' - 6y' + 5y =exp(-3t)
% and plots the families of solutions for different values of the constants
% C1 and C2.

%define the function of interest
syms y(t) t;

%compute derivatives of y(t) with respect to t using diff() function
Dy  = diff(y(t));
Dy2 = diff(y(t),2);  %the 2 as second argument indicates 2nd order derivative

%define the differential equation
ode = Dy2 - 6*Dy + 5*y == exp(-3*t)
```

ode(t) =

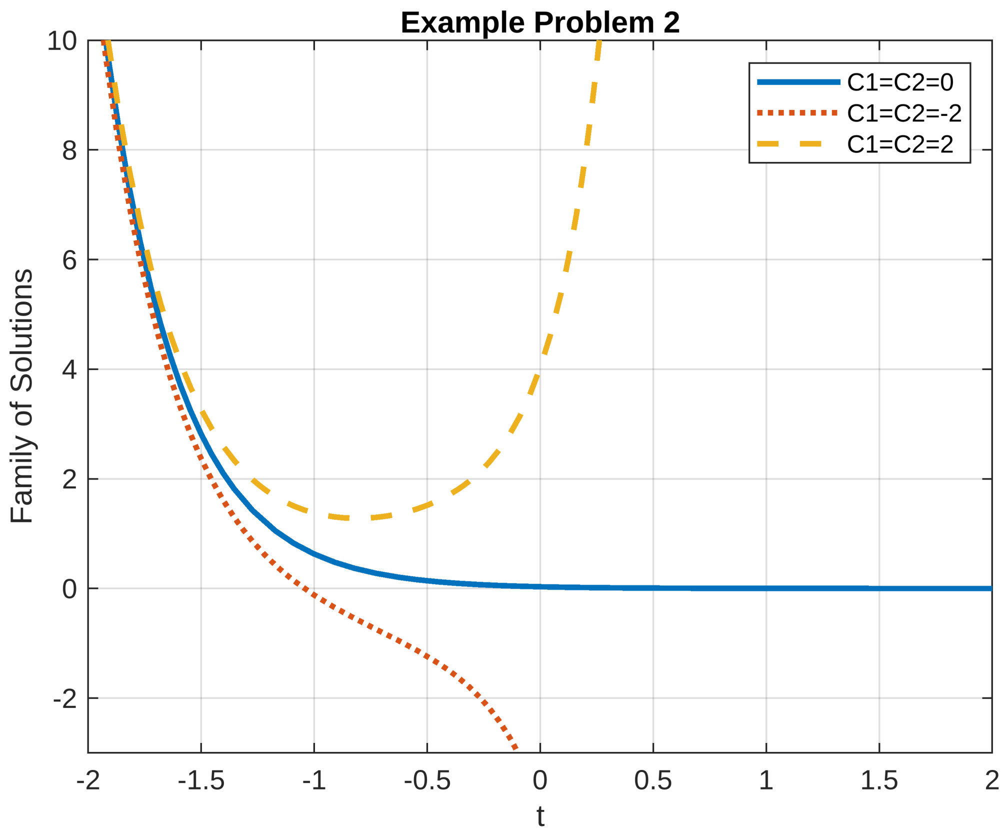
$$\frac{\partial^2}{\partial t^2}\, y(t) - 6\frac{\partial}{\partial t}\, y(t) + 5\, y(t) = \mathrm{e}^{-3\,t}$$

```
%solve the differential equation using dsolve()
ySoln(t) = dsolve(ode)
```

```
ySoln(t) =
```

$$\frac{e^{-3t}}{32} + C_1 e^{t} + C_2 e^{5t}$$

```
%plot family of solutions for different values of C1 and C2
C1 = 0;
C2 = 0;
ySoln1 = exp(-3*t)/32 + C1*exp(t) + C2*exp(5*t);

C1 = -2;
C2 = -2;
ySoln2 = exp(-3*t)/32 + C1*exp(t) + C2*exp(5*t);

C1 = 2;
C2 = 2;
ySoln3 = exp(-3*t)/32 + C1*exp(t) + C2*exp(5*t);

figure;
fplot(ySoln1,[-2 2],'-','linewidth',2);
hold on;
fplot(ySoln2,[-2 2],':','linewidth',2);
fplot(ySoln3,[-2 2],'--','linewidth',2);
xlabel('t');
ylabel('Family of Solutions');
title('Example Problem 2');
grid on;
ylim([-3 10]);
legend('C1=C2=0','C1=C2=-2','C1=C2=2');
```

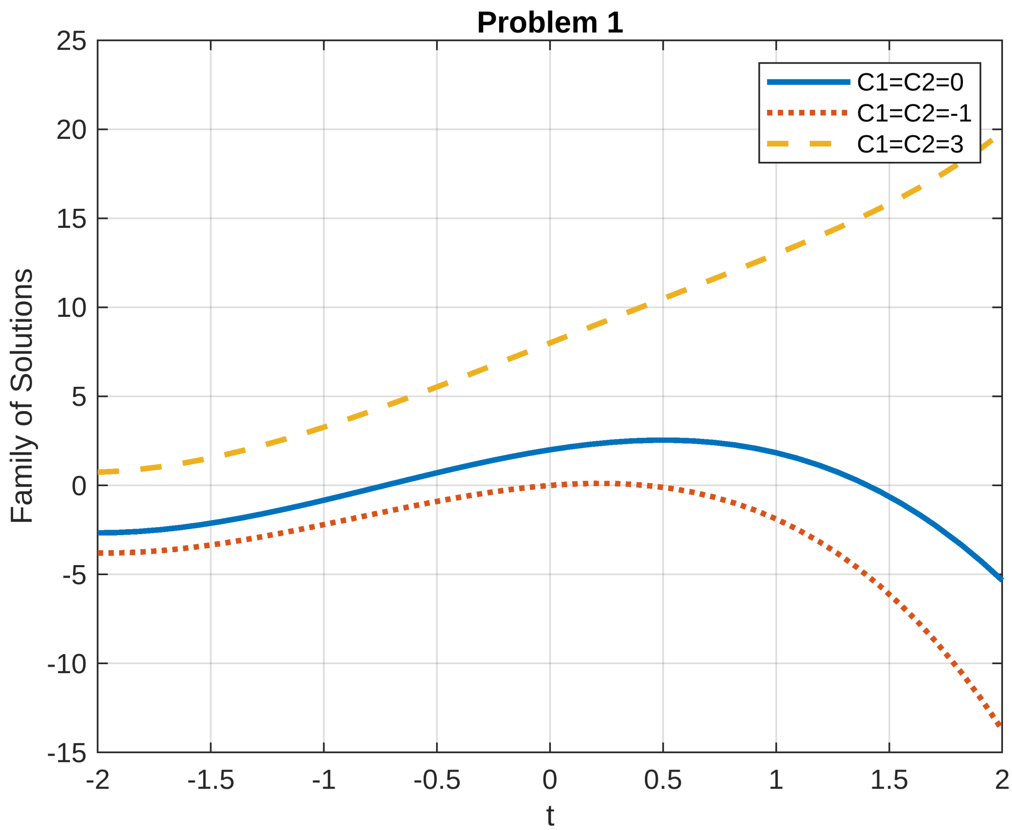


Problems:

Problem 1: Use the MATLAB dsolve() function to solve the differential equation $y'' - y' = 2t^2 - t - 5$. Plot the family of solutions on a single plot for $C_1 = C_2 = 0$ as a solid curve, $C_1 = C_2 = -1$ as a dotted curve, and $C_1 = C_2 = 3$ as a dashed curve. Make sure to label both axes, title your figure, and turn on the plotting legend. Set the y-axis limits to [-15 25].

```
%[Insert your MATLAB code and plot here.]
syms y(t) t;

Dy = diff(y(t));
Dy2 = diff(y(t),2);

ode = Dy2 - Dy == 2*t^2 -t -5;

%use dsolve
ySoln(t) = dsolve(ode);

C1 = 0;
C2 = 0;
ySoln1 = C1 + 2*t + C2 * exp(t) - (3*t^2)/2 - (2*t^3)/3 + 2;

C1 = -1;
```

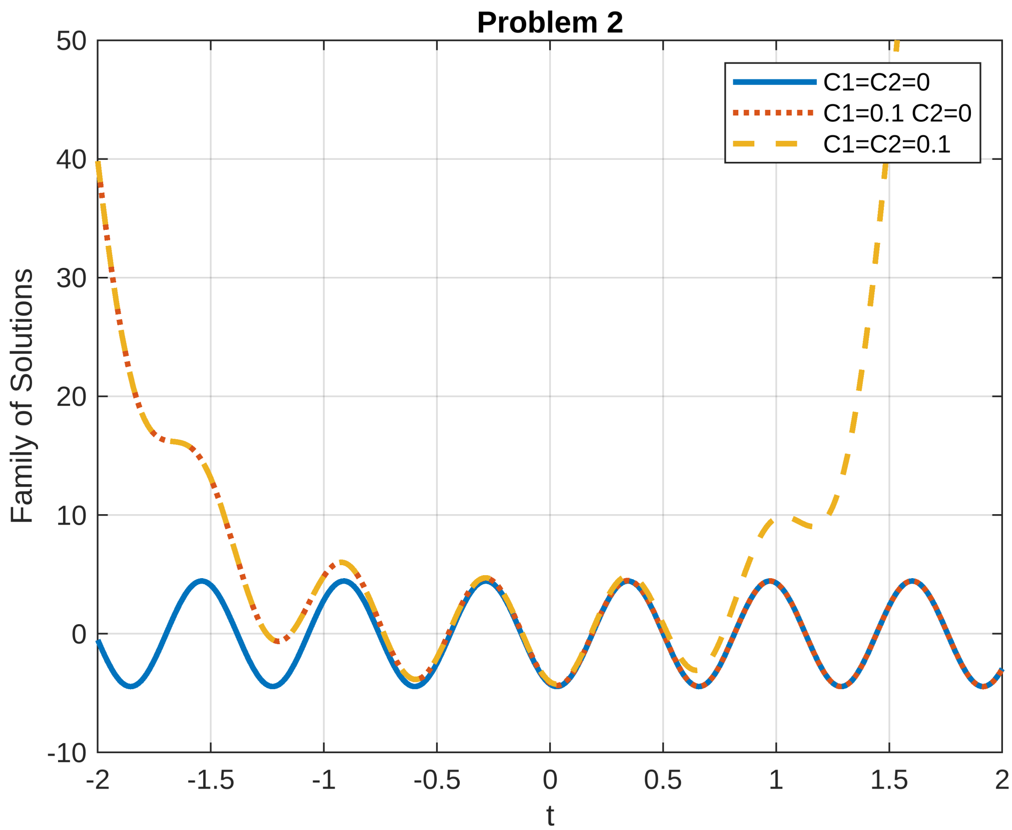
```
C2 = -1;
ySoln2 = C1 + 2*t + C2 * exp(t) - (3*t^2)/2 - (2*t^3)/3 + 2;

C1 = 3;
C2 = 3;
ySoln3 = C1 + 2*t + C2 * exp(t) - (3*t^2)/2 - (2*t^3)/3 +2;

%figure
figure;

%plot
fplot(ySoln1, [-2, 2], '-', 'LineWidth', 2);
%hold on
hold on;
fplot(ySoln2, [-2, 2], ':', 'LineWidth', 2);
fplot(ySoln3, [-2, 2], '--', 'LineWidth', 2);

%label axes
%title
xlabel('t');
ylabel('Family of Solutions');
title('Problem 1');

%grid on
grid on;

%y limit
ylim([-15, 25]);

%legend
legend('C1=C2=0', 'C1=C2=-1', 'C1=C2=3');
```



Problem 2: Use the MATLAB dsolve() function to solve the differential equation $y'' - y' - 12y = 500\cos(10t)$. Plot the family of solutions on a single plot for $C_1 = C_2 = 0$ as a solid curve, $C_1 = 0.1, C_2 = 0$ as a dotted curve, and $C_1 = C_2 = 0.1$ as a dashed curve. Make sure to label both axes, title your figure, and turn on the plotting legend. Set the y-axis limits to [-10 50].

```
%[Insert your MATLAB code and plot here.]
syms y(t) t;
Dy = diff(y(t));
Dy2 = diff(y(t),2);

ode = Dy2 - Dy - 12*y == 500*cos(10*t);

%suse dsolve
ySoln(t) = dsolve(ode);

C1 = 0;
C2 = 0;
ySoln1 = C1 * exp(-3*t) - (250*sqrt(3161) * cos(10*t - atan(5/16)))/3161 +
C2 * exp(4*t);
```

```
C1 = 0.1;
C2 = 0;
ySoln2 = C1 * exp(-3*t) - (250*sqrt(3161) * cos(10*t - atan(5/16)))/3161 +
C2 * exp(4*t);

C1 = 0.1;
C2 = 0.1;
ySoln3 = C1 * exp( -3*t) - (250*sqrt(3161) * cos(10*t - atan(5/16)))/3161 +
C2 * exp(4*t);

%figure
figure;

%plot
fplot(ySoln1, [-2, 2], '-', 'LineWidth', 2);
%hold on
hold on;
fplot(ySoln2, [-2, 2], ':', 'LineWidth', 2);
fplot(ySoln3, [-2, 2], '--', 'LineWidth', 2);

%axes labels
%title
xlabel('t');
ylabel('Family of Solutions');
title('Problem 2');

%grid on
grid on;

%y lims
ylim([-10, 50]);

%legend
legend('C1=C2=0', 'C1=0.1 C2=0', 'C1=C2=0.1');
```



Problem 3: For the differential equation solved in Problem 2, will any specific values of C_1 and C_2 cause the solution to converge to zero as $t \to \infty$? Yes or no? Explain.

[Insert your math/explanation here. Since we more than one set, they could share about the same path as it approaches infinity. But I would have to answer yes based on the graph because the solutions could have different solutions but have a similar equlibruim path as they move towards positive infinity.

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