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%%Yizhan Ao & Yisheng Leng MATLAB 05 246

## Problem 13 Part A

```
syms s t y(t) Y;
g = heaviside(t-pi())*(1) + heaviside(t-10)*(-1)
ezplot(g,[0,15]);
eqn = diff(y,2) + 3*diff(y) + 2*y == g;
lteqn = laplace(eqn, t, s);
neweqn = subs(lteqn, [laplace(y(t),t,s), y(0),subs(diff(y(t),t),t,0)],
    {Y, 1, 0});
ytrans = simplify(solve(neweqn,Y));
solution5 = ilaplace(ytrans, s, t);
figure
plot3 = ezplot(solution5, [0,15])
set(plot3, 'linewidth', 3, 'color', 'r')
axis auto
xlabel t, ylabel y
title 'Problem 13 Part A - LaPlace Method Solution'
```

$g =$

$\text{heaviside}(t - \pi) - \text{heaviside}(t - 10)$

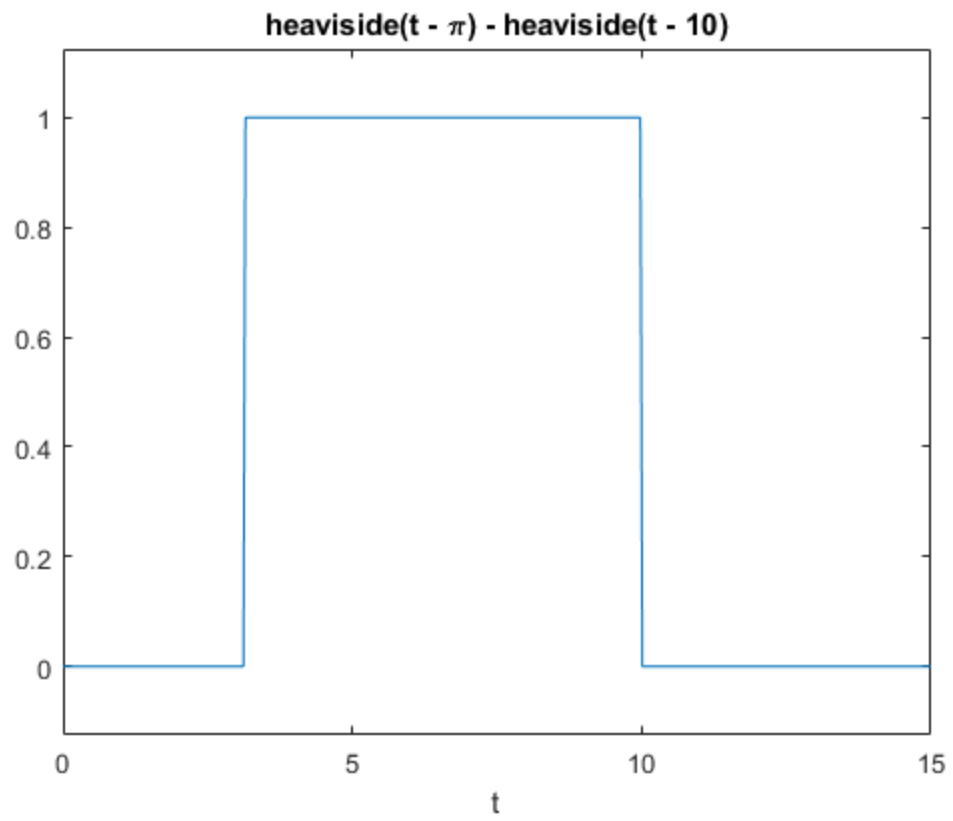
$\text{plot3} =$

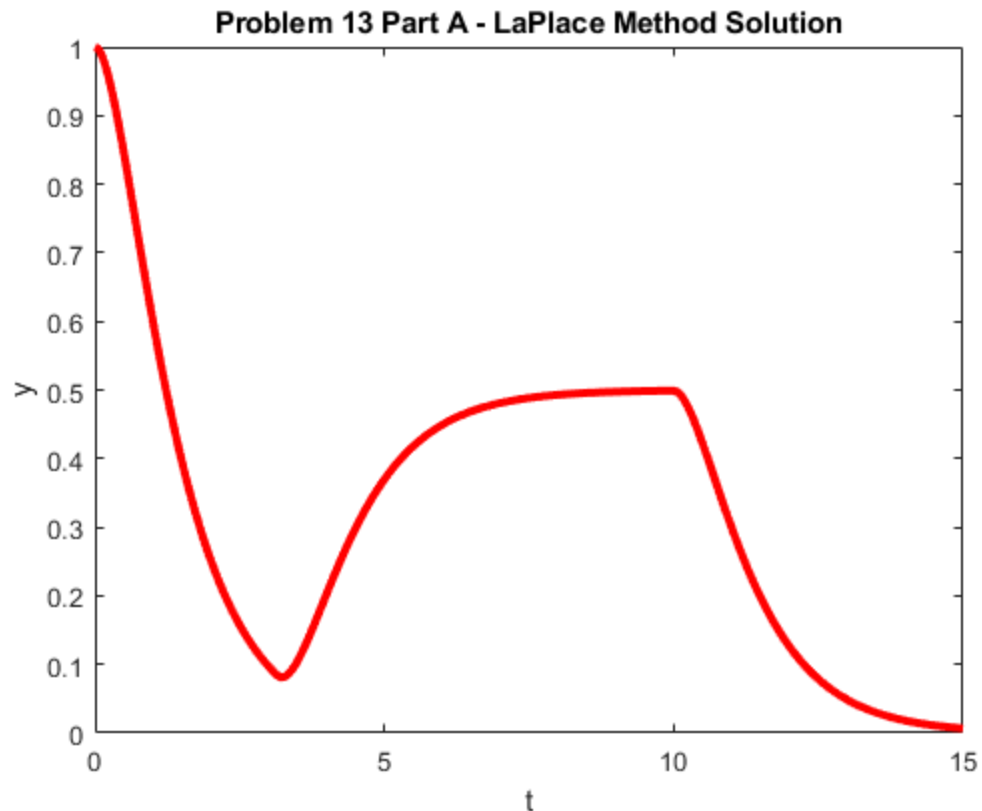
*Line with properties:*

```
Color: [0 0.4470 0.7410]
LineStyle: '-'
LineWidth: 0.5000
Marker: 'none'
MarkerSize: 6
MarkerFaceColor: 'none'
XData: [1x434 double]
YData: [1x434 double]
ZData: [1x0 double]
```

---

*Use GET to show all properties*





## Problem 14 Part B

Use the Laplace Transform method to solve the following initial value problems. See problem 13 for additional instructions.

```
figure; hold on
syms s t y(t) Y
h = heaviside(t-5)-2*heaviside(t-10);
ezplot(h);
eqn = diff(y,2)+ 6*diff(y)+8*y == h;
lteqn = laplace(eqn,t,s);
neweqn = subs(lteqn, [laplace(y(t),t,s),y(0),subs(diff(y(t),t),t,0)],
    [Y,0,2])
ytrans = simplify(solve(neweqn, Y))
y= ilaplace(ytrans,s,t)
plot1 = ezplot(y, [0 15])
set(plot1, 'linewidth', 3, 'color', 'r')
axis auto
xlabel t, ylabel y
title 'Problem 14 Part B - LaPlace Method Solution'
hold off
```

*neweqn =*

$$Y*s^2 + 6*Y*s + 8*Y - 2 == \exp(-5*s)/s - (2*\exp(-10*s))/s$$

---

```
ytrans =
```

```
(2*s + exp(-5*s) - 2*exp(-10*s))/(s*(s^2 + 6*s + 8))
```

```
y =
```

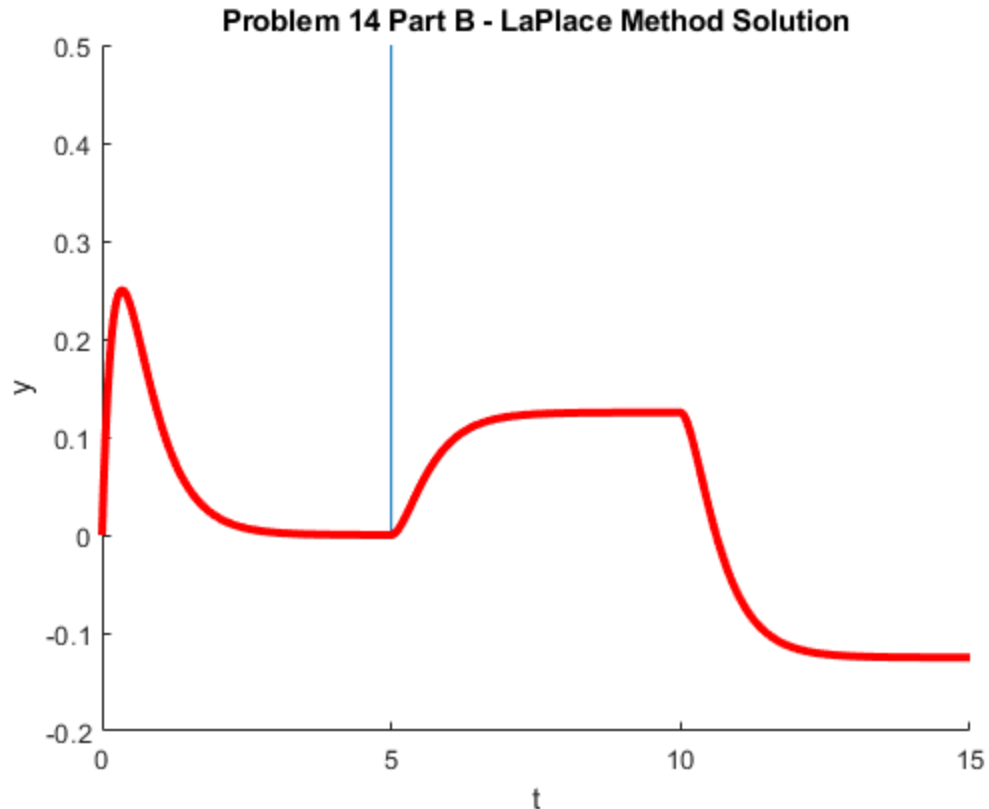
```
exp(-2*t) - exp(-4*t) + heaviside(t - 5)*(exp(20 - 4*t)/8 - exp(10  
- 2*t)/4 + 1/8) - 2*heaviside(t - 10)*(exp(40 - 4*t)/8 - exp(20 -  
2*t)/4 + 1/8)
```

```
plot1 =
```

```
Line with properties:
```

```
Color: [0.8500 0.3250 0.0980]  
LineStyle: '-'  
LineWidth: 0.5000  
Marker: 'none'  
MarkerSize: 6  
MarkerFaceColor: 'none'  
XData: [1×434 double]  
YData: [1×434 double]  
ZData: [1×0 double]
```

```
Use GET to show all properties
```



## Problem 17 Part A

```
tic
figure; hold on
sol2=dsolve('D2y+Dy+y=((t+1)^3)*exp(-
t)*cos(t)*sin(3*t)','y(0)=1','Dy(0)=0')
p17partA = ezplot(sol2, [0 15])
set(p17partA, 'linewidth', 3, 'color', 'r')
axis auto
xlabel t, ylabel y
title 'Problem 17 Part A - Dsolve Method Solution'
hold off
toc
```

```
% Using the dsolve method from previous chapters for second order
% differential equations, it took about 0.46 seconds to get a result.
% However these results may vary because tic and toc depends on the
% program
% being used and the speed of the computer running the program. In
% this
% case, the LaPlace Transform method seemed to produce results faster.
```

*Warning: Support of character vectors and strings will be removed in a future release. Use sym objects to define differential equations instead.*

---

sol2 =

$$\begin{aligned} & (208760666888776 \cdot \exp(-t/2) \cdot \cos((3^{1/2} \cdot t)/2)) / 96347750544721 + \\ & (58400630975296 \cdot 3^{1/2} \cdot \exp(-t/2) \cdot \sin((3^{1/2} \cdot t)/2)) / 289043251634163 \\ & + \exp(-t/2) \cdot \cos((3^{1/2} \cdot t)/2) \cdot (\exp(-t \cdot 4i - (3^{1/2} \cdot t \cdot 1i)/2)) \cdot (\exp(-t/2) \cdot (3^{1/2} \cdot (319856713/20240415366 + 318553609i/20240415366) - \\ & 79743641/6746805122 - 25398489i/13493610244) - \exp(t \cdot (-1/2 + 8i)) \cdot (3^{1/2} \cdot (319856713/20240415366 - 318553609i/20240415366) \\ & + 79743641/6746805122 - 25398489i/13493610244) + \exp(t \cdot (-1/2 + 2i)) \cdot (3^{1/2} \cdot (16205/85683 - 16643i/342732) - 31973/114244 \\ & + 12801i/114244) - \exp(t \cdot (-1/2 + 6i)) \cdot (3^{1/2} \cdot (16205/85683 + 16643i/342732) + 31973/114244 + 12801i/114244) + t \cdot \exp(t \cdot (-1/2 + 2i)) \cdot (3^{1/2} \cdot (3849/17576 + 1881i/8788) - 2559/8788 - 3867i/17576) \\ & - t \cdot \exp(t \cdot (-1/2 + 6i)) \cdot (3^{1/2} \cdot (3849/17576 - 1881i/8788) + 2559/8788 - 3867i/17576) + t \cdot \exp(-t/2) \cdot (3^{1/2} \cdot (3272277/111980168 \\ & + 1824465i/27995042) - 615567/27995042 - 2745159i/111980168) - t \cdot \exp(t \cdot (-1/2 + 8i)) \cdot (3^{1/2} \cdot (3272277/111980168 - 1824465i/27995042) \\ & + 615567/27995042 - 2745159i/111980168) - t^3 \cdot \exp(t \cdot (-1/2 + 2i)) \cdot (3^{1/2} \cdot (5/312 - 7i/156) - 1/52 + 3i/104) \\ & + t^3 \cdot \exp(t \cdot (-1/2 + 6i)) \cdot (3^{1/2} \cdot (5/312 + 7i/156) + 1/52 + 3i/104) + t^2 \cdot \exp(t \cdot (-1/2 + 2i)) \cdot (3^{1/2} \cdot (7/338 + 135i/676) - 9/676 - 123i/676) \\ & - t^2 \cdot \exp(t \cdot (-1/2 + 6i)) \cdot (3^{1/2} \cdot (7/338 - 135i/676) + 9/676 - 123i/676) - t^3 \cdot \exp(-t/2) \cdot (3^{1/2} \cdot (17/5784 - 31i/1446) - 1/482 + 15i/1928) \\ & + t^3 \cdot \exp(t \cdot (-1/2 + 8i)) \cdot (3^{1/2} \cdot (17/5784 + 31i/1446) + 1/482 + 15i/1928) + t^2 \cdot \exp(-t/2) \cdot (3^{1/2} \cdot (470/58081 + 8043i/116162) - 621/116162 - 6549i/232324) - t^2 \cdot \exp(t \cdot (-1/2 + 8i)) \cdot (3^{1/2} \cdot (470/58081 - 8043i/116162) + 621/116162 - 6549i/232324)) - \exp(-t \cdot 4i + (3^{1/2} \cdot t \cdot 1i)/2) \cdot (\exp(-t/2) \cdot (3^{1/2} \cdot (319856713/20240415366 + 318553609i/20240415366) \\ & + 79743641/6746805122 + 25398489i/13493610244) - \exp(t \cdot (-1/2 + 8i)) \cdot (3^{1/2} \cdot (319856713/20240415366 - 318553609i/20240415366) - 79743641/6746805122 + 25398489i/13493610244) + \exp(t \cdot (-1/2 + 2i)) \cdot (3^{1/2} \cdot (16205/85683 - 16643i/342732) + 31973/114244 - 12801i/114244) - \exp(t \cdot (-1/2 + 6i)) \cdot (3^{1/2} \cdot (16205/85683 + 16643i/342732) - 31973/114244 - 12801i/114244) + t \cdot \exp(t \cdot (-1/2 + 2i)) \cdot (3^{1/2} \cdot (3849/17576 + 1881i/8788) + 2559/8788 + 3867i/17576) - t \cdot \exp(t \cdot (-1/2 + 6i)) \cdot (3^{1/2} \cdot (3849/17576 - 1881i/8788) - 2559/8788 + 3867i/17576) + t \cdot \exp(-t/2) \cdot (3^{1/2} \cdot (3272277/111980168 + 1824465i/27995042) + 615567/27995042 + 2745159i/111980168) - t \cdot \exp(t \cdot (-1/2 + 8i)) \cdot (3^{1/2} \cdot (3272277/111980168 - 1824465i/27995042) - 615567/27995042 + 2745159i/111980168) - t^3 \cdot \exp(t \cdot (-1/2 + 2i)) \cdot (3^{1/2} \cdot (5/312 - 7i/156) + 1/52 - 3i/104) + t^3 \cdot \exp(t \cdot (-1/2 + 6i)) \cdot (3^{1/2} \cdot (5/312 + 7i/156) - 1/52 - 3i/104) + t^2 \cdot \exp(t \cdot (-1/2 + 2i)) \cdot (3^{1/2} \cdot (7/338 + 135i/676) + 9/676 + 123i/676) - t^2 \cdot \exp(t \cdot (-1/2 + 6i)) \cdot (3^{1/2} \cdot (7/338 - 135i/676) - 9/676 + 123i/676) - t^3 \cdot \exp(-t/2) \cdot (3^{1/2} \cdot (17/5784 - 31i/1446) + 1/482 - 15i/1928) + t^3 \cdot \exp(t \cdot (-1/2 + 8i)) \cdot (3^{1/2} \cdot (17/5784 + 31i/1446) - 1/482 - 15i/1928) + t^2 \cdot \exp(-t/2) \cdot (3^{1/2} \cdot (470/58081 + 8043i/116162) + 621/116162 + 6549i/232324) - t^2 \cdot \exp(t \cdot (-1/2 + 8i)) \cdot (3^{1/2} \cdot (470/58081 - 8043i/116162) - 621/116162 + 6549i/232324))) - \exp(-t/2) \cdot \sin((3^{1/2} \cdot t)/2) \cdot (\exp(-t \cdot 4i - (3^{1/2} \cdot t \cdot 1i)/2)) \cdot (\exp(-t/2) \cdot (3^{1/2} \cdot (318553609/20240415366 - 319856713i/20240415366) - 25398489/13493610244 + 79743641i/6746805122) + \exp(t \cdot (-1/2 + 8i)) \cdot (3^{1/2} \cdot (318553609/20240415366 + 319856713i/20240415366) - 25398489/13493610244 - 79743641i/6746805122) - \exp(t \cdot (-1/2 + 2i)) \cdot (3^{1/2} \cdot (318553609/20240415366 - 319856713i/20240415366) + 25398489/13493610244 + 79743641i/6746805122) - \exp(t \cdot (-1/2 + 6i)) \cdot (3^{1/2} \cdot (318553609/20240415366 + 319856713i/20240415366) - 25398489/13493610244 - 79743641i/6746805122)) \end{aligned}$$

---

```

8i))*(3^(1/2)*(318553609/20240415366 + 319856713i/20240415366)
+ 25398489/13493610244 + 79743641i/6746805122) - exp(t*(- 1/2
+ 2i))*(3^(1/2)*(16643/342732 + 16205i/85683) - 12801/114244 -
31973i/114244) - exp(t*(- 1/2 + 6i))*(3^(1/2)*(16643/342732 -
16205i/85683) + 12801/114244 - 31973i/114244) + t*exp(t*(- 1/2 +
2i))*(3^(1/2)*(1881/8788 - 3849i/17576) - 3867/17576 + 2559i/8788)
+ t*exp(t*(- 1/2 + 6i))*(3^(1/2)*(1881/8788 + 3849i/17576) +
3867/17576 + 2559i/8788) + t*exp(-t/2)*(3^(1/2)*(1824465/27995042
- 3272277i/111980168) - 2745159/111980168 + 615567i/27995042)
+ t*exp(t*(- 1/2 + 8i))*(3^(1/2)*(1824465/27995042 +
3272277i/111980168) + 2745159/111980168 + 615567i/27995042) +
t^3*exp(t*(- 1/2 + 2i))*(3^(1/2)*(7/156 + 5i/312) - 3/104 - 1i/52)
+ t^3*exp(t*(- 1/2 + 6i))*(3^(1/2)*(7/156 - 5i/312) + 3/104 - 1i/52)
+ t^2*exp(t*(- 1/2 + 2i))*(3^(1/2)*(135/676 - 7i/338) - 123/676
+ 9i/676) + t^2*exp(t*(- 1/2 + 6i))*(3^(1/2)*(135/676 + 7i/338)
+ 123/676 + 9i/676) + t^3*exp(-t/2)*(3^(1/2)*(31/1446 + 17i/5784)
- 15/1928 - 1i/482) + t^3*exp(t*(- 1/2 + 8i))*(3^(1/2)*(31/1446 -
17i/5784) + 15/1928 - 1i/482) + t^2*exp(-t/2)*(3^(1/2)*(8043/116162
- 470i/58081) - 6549/232324 + 621i/116162) + t^2*exp(t*(-
1/2 + 8i))*(3^(1/2)*(8043/116162 + 470i/58081) + 6549/232324
+ 621i/116162)) + exp(- t*4i + (3^(1/2)*t*1i)/2)*(exp(-
t/2)*(3^(1/2)*(318553609/20240415366 - 319856713i/20240415366)
+ 25398489/13493610244 - 79743641i/6746805122) + exp(t*(- 1/2 +
8i))*(3^(1/2)*(318553609/20240415366 + 319856713i/20240415366)
- 25398489/13493610244 - 79743641i/6746805122) - exp(t*(- 1/2
+ 2i))*(3^(1/2)*(16643/342732 + 16205i/85683) + 12801/114244 +
31973i/114244) - exp(t*(- 1/2 + 6i))*(3^(1/2)*(16643/342732 -
16205i/85683) - 12801/114244 + 31973i/114244) + t*exp(t*(- 1/2 +
2i))*(3^(1/2)*(1881/8788 - 3849i/17576) + 3867/17576 - 2559i/8788)
+ t*exp(t*(- 1/2 + 6i))*(3^(1/2)*(1881/8788 + 3849i/17576) -
3867/17576 - 2559i/8788) + t*exp(-t/2)*(3^(1/2)*(1824465/27995042
- 3272277i/111980168) + 2745159/111980168 - 615567i/27995042)
+ t*exp(t*(- 1/2 + 8i))*(3^(1/2)*(1824465/27995042 +
3272277i/111980168) - 2745159/111980168 - 615567i/27995042) +
t^3*exp(t*(- 1/2 + 2i))*(3^(1/2)*(7/156 + 5i/312) + 3/104 + 1i/52)
+ t^3*exp(t*(- 1/2 + 6i))*(3^(1/2)*(7/156 - 5i/312) - 3/104 + 1i/52)
+ t^2*exp(t*(- 1/2 + 2i))*(3^(1/2)*(135/676 - 7i/338) + 123/676
- 9i/676) + t^2*exp(t*(- 1/2 + 6i))*(3^(1/2)*(135/676 + 7i/338)
- 123/676 - 9i/676) + t^3*exp(-t/2)*(3^(1/2)*(31/1446 + 17i/5784)
+ 15/1928 + 1i/482) + t^3*exp(t*(- 1/2 + 8i))*(3^(1/2)*(31/1446 -
17i/5784) - 15/1928 + 1i/482) + t^2*exp(-t/2)*(3^(1/2)*(8043/116162
- 470i/58081) + 6549/232324 - 621i/116162) + t^2*exp(t*(- 1/2
+ 8i))*(3^(1/2)*(8043/116162 + 470i/58081) - 6549/232324 -
621i/116162)))

```

p17partA =

Line with properties:

```

Color: [0 0.4470 0.7410]
LineStyle: '-'
LineWidth: 0.5000
Marker: 'none'

```

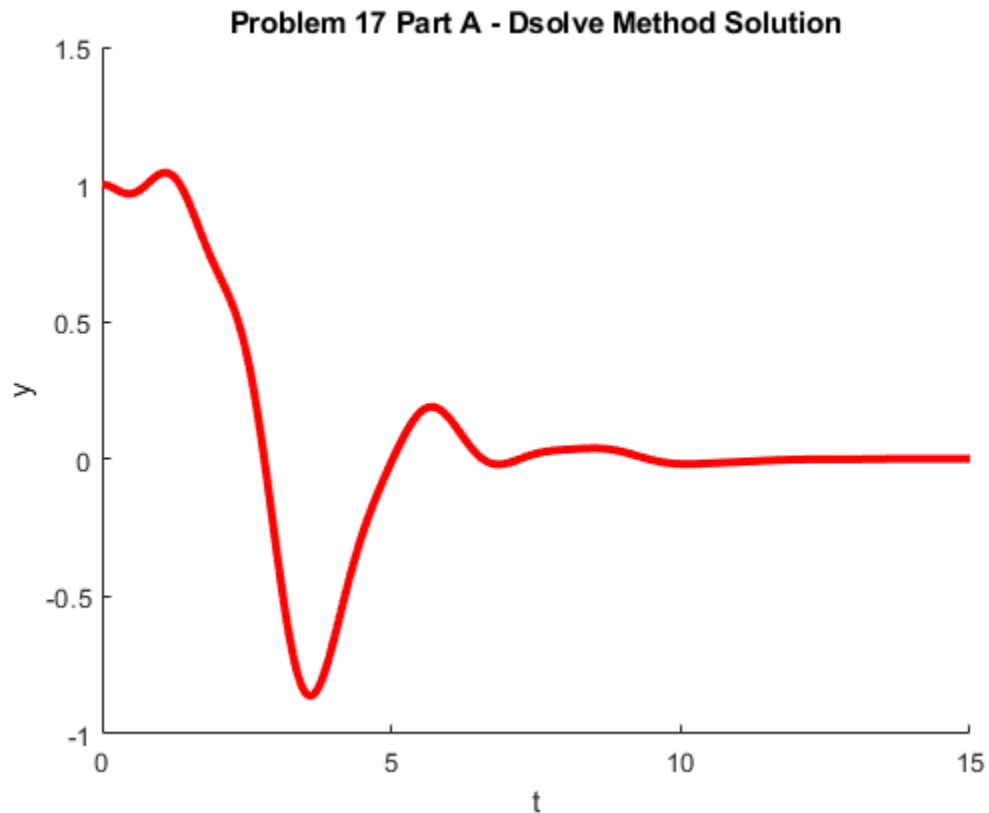
```

MarkerSize: 6
MarkerFaceColor: 'none'
XData: [1×434 double]
YData: [1×434 double]
ZData: [1×0 double]

```

Use GET to show all properties

Elapsed time is 0.424025 seconds.



## Problem 17 Part B

```

tic
syms t s y(t) Y
figure; hold on
eqn1 = diff(y,2)+ diff(y)+y(t)==((t+1)^3)*exp(-t)*cos(t)*sin(3*t);
lteqn1 = laplace(eqn1, t, s)
neweqn1 = subs(lteqn1, [laplace(y(t),t,s), y(0),
    subs(diff(y(t),t),t,0)], [Y, 1, 0])
ytrans1 = simplify(solve(neweqn1, Y))
y1 = ilaplace(ytrans1, s, t)
p17partB = ezplot(y1, [0 15])
set(p17partB, 'linewidth', 3, 'color', 'b')
axis auto
xlabel t, ylabel y
title 'Problem 17 Part B - LaPlace Method Solution'

```



---

```

hold off
toc

% Using the LaPlace Transform method from chapter 13, it took about
0.23
% seconds to get a result. However these results may vary because tic
and
% toc depend on the program being used and the speed of the computer
% running the program. In this case, the LaPlace Transform method
seemed to
% produce results faster.

lteqn1 =

s*laplace(y(t), t, s) - y(0) - s*y(0) + s^2*laplace(y(t), t, s) -
subs(diff(y(t), t), t, 0) + laplace(y(t), t, s) == (2*s^6 + 24*s^5 +
150*s^4 + 544*s^3 + 1134*s^2 + 1128*s + 346)/(2*(s^8 + 8*s^7 + 44*s^6
+ 152*s^5 + 406*s^4 + 760*s^3 + 1100*s^2 + 1000*s + 625)) + (4*s^6 +
48*s^5 + 444*s^4 + 2240*s^3 + 8316*s^2 + 16080*s + 19844)/(2*(s^8 +
8*s^7 + 92*s^6 + 440*s^5 + 2566*s^4 + 7480*s^3 + 26588*s^2 + 39304*s
+ 83521))

neweqn1 =

Y - s + Y*s + Y*s^2 - 1 == (2*s^6 + 24*s^5 + 150*s^4 + 544*s^3 +
1134*s^2 + 1128*s + 346)/(2*(s^8 + 8*s^7 + 44*s^6 + 152*s^5 + 406*s^4
+ 760*s^3 + 1100*s^2 + 1000*s + 625)) + (4*s^6 + 48*s^5 + 444*s^4
+ 2240*s^3 + 8316*s^2 + 16080*s + 19844)/(2*(s^8 + 8*s^7 + 92*s^6 +
440*s^5 + 2566*s^4 + 7480*s^3 + 26588*s^2 + 39304*s + 83521))

ytrans1 =

(s^17 + 17*s^16 + 216*s^15 + 1883*s^14 + 13496*s^13 + 77881*s^12
+ 382776*s^11 + 1585099*s^10 + 5657314*s^9 + 17221099*s^8 +
45092776*s^7 + 100147529*s^6 + 188387568*s^5 + 292748555*s^4 +
368303432*s^3 + 351557137*s^2 + 229139061*s + 72851008)/((s^2 + s +
1)*(s^4 + 4*s^3 + 26*s^2 + 44*s + 85)^4)

y1 =

(208760666888776*exp(-t/2)*(cos((3^(1/2)*t)/2) +
(7300078871912*3^(1/2)*sin((3^(1/2)*t)/2))/78285250083291))/96347750544721
- (exp(-t)*(60*t*cos(4*t) - 15*sin(4*t) - 45*t*sin(4*t)
+ 180*t^2*cos(4*t) - 64*t^3*cos(4*t) + 96*t^2*sin(4*t) +
240*t^3*sin(4*t)))/7712 - (3*exp(-t)*(336*t*cos(2*t) - 168*sin(2*t)
+ 27*t*sin(2*t) - 54*t^2*cos(2*t) + 224*t^2*sin(2*t)))/1352 -
(3*exp(-t)*(46608*t*cos(4*t) - 11652*sin(4*t) + 303*t*sin(4*t)
- 1212*t^2*cos(4*t) + 62144*t^2*sin(4*t)))/1858592 - (3*exp(-
t)*(766*t*cos(2*t) - 383*sin(2*t) + 5312*t*sin(2*t)))/17576
- (3*exp(-t)*(737948*t*cos(4*t) - 184487*sin(4*t) +

```

---

---

```

15439040*t*sin(4*t))/447920672 - (31973*exp(-t)*(cos(2*t)
+ (7665*sin(2*t))/63946))/28561 - (exp(-t)*(30*t*cos(2*t) -
15*sin(2*t) - 9*t*sin(2*t) + 18*t^2*cos(2*t) - 8*t^3*cos(2*t)
+ 24*t^2*sin(2*t) + 12*t^3*sin(2*t)))/104 - (159487282*exp(-
t)*(cos(4*t) + (199148625*sin(4*t))/318974564))/3373402561

```

```
p17partB =
```

```
Line with properties:
```

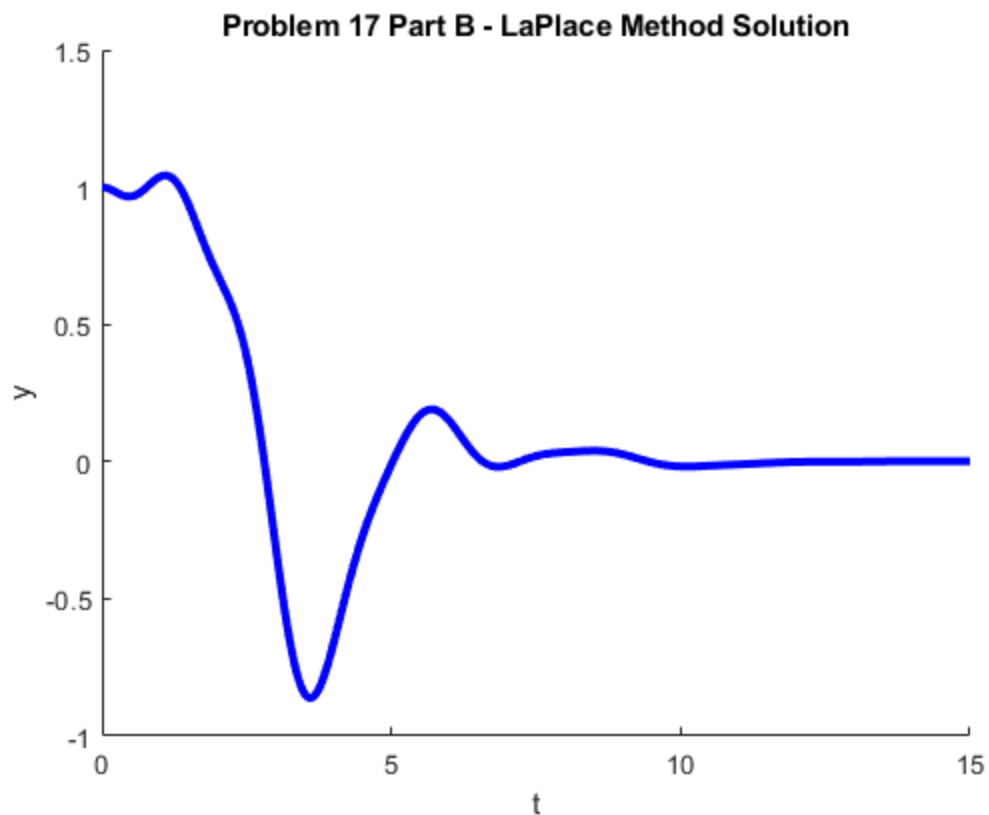
```

        Color: [0 0.4470 0.7410]
        LineStyle: '-'
        LineWidth: 0.5000
        Marker: 'none'
        MarkerSize: 6
        MarkerFaceColor: 'none'
        XData: [1×434 double]
        YData: [1×434 double]
        ZData: [1×0 double]

```

```
Use GET to show all properties
```

```
Elapsed time is 0.932839 seconds.
```



---

## Problem 17 Part C

```
figure; hold on
p17partB = ezplot(y1, [0 15])
p17partA = ezplot(sol2, [0 15])
set(p17partA, 'linewidth', 3, 'color', 'k')
set(p17partB, 'linewidth', 3, 'color', 'k')
axis auto
xlabel t, ylabel y
title 'Problem 17 Part A and B Solutions Plotted Together'
hold off

% Both the dsolve graph and the LaPlace Transform graph are the same.

p17partB =

    Line with properties:

        Color: [0 0.4470 0.7410]
        LineStyle: '-'
        LineWidth: 0.5000
        Marker: 'none'
        MarkerSize: 6
        MarkerFaceColor: 'none'
        XData: [1×434 double]
        YData: [1×434 double]
        ZData: [1×0 double]

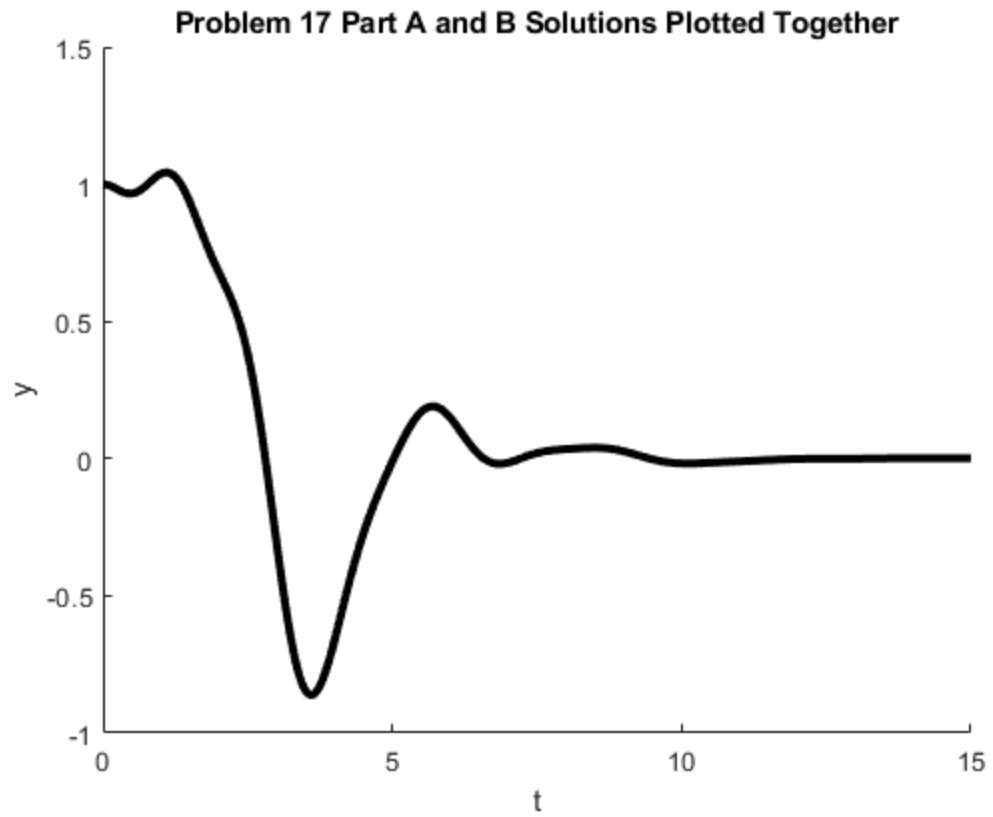
    Use GET to show all properties

p17partA =

    Line with properties:

        Color: [0.8500 0.3250 0.0980]
        LineStyle: '-'
        LineWidth: 0.5000
        Marker: 'none'
        MarkerSize: 6
        MarkerFaceColor: 'none'
        XData: [1×434 double]
        YData: [1×434 double]
        ZData: [1×0 double]

    Use GET to show all properties
```



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