Signals and Systems Lab 5

Submitted by

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Experiment 1 : Find the laplace transform of

- Code :

```
syms t
f = t*t;
laplace(f)
```

Output :

```
>> lab5_1

ans =

2/s^3
```

- $y = e^{-at} + e^{-3at}$

Code :

```
syms a t
f = exp(-a*t) + exp(-3*a*t);
laplace(f)
```

Output :

```
>> lab5_1ii

ans =

1/(a + s) + 1/(3*a + s)
```

- $y = e^{2t}\sin(2t)$

Code:

```
syms t
f = exp(2*t)*sin(2*t);
laplace(f)
```

Output :

```
>> lab5_1iii

ans =

2/((s - 2)^2 + 4)
```

- $y = e^{3t} + \cos(6t) - e^{-3t}\cos(6t)$

  Code:
```
syms t
f = exp(3*t) + cos(6*t) - exp(-3*t)*cos(6*t);
laplace(f)
```
  Output :
```
>> lab5_1iv

ans =

1/(s - 3) - (s + 3)/((s + 3)^2 + 36) + s/(s^2 + 36)
```

- $y = u(t-2) + 2u(t-3) - 2r(t-2)$

  Code :
```
syms t
f = heaviside(t-2) + 2*heaviside(t-3) - 2*(t-3)*heaviside(t-3);
laplace(f)
```
  Output :
```
>> lab5_1v

ans =

exp(-2*s)/s + (2*exp(-3*s))/s - (2*exp(-3*s))/s^2
```

Experiment 2 :

Consider the two functions $f(t) = u(t)u(3 - t)$ and $g(t) = u(t) - u(t - 3)$.

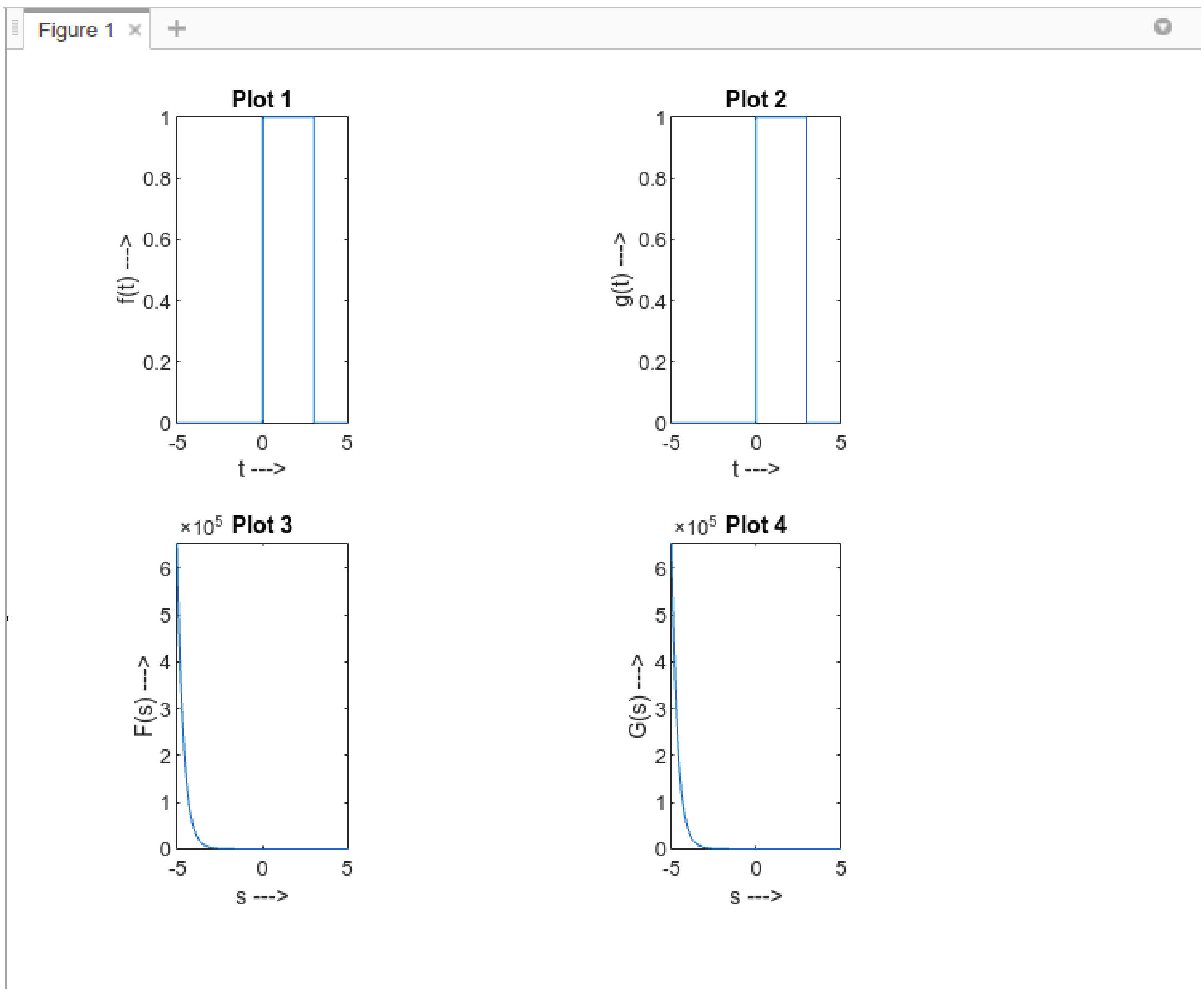
(a) Are the two functions identical?

(b) Show that $L[f(t)] = L[g(t)]$

Code :
```
syms t
%% define f(t)
f = heaviside(t)*heaviside(3-t);
subplot(2,4,1)
fplot(f)
xlabel('t --->')
ylabel('f(t) --->')
%% define g(t)
g = heaviside(t) - heaviside(t-3);
subplot(2,4,3)
fplot(g)
xlabel('t --->')
```

```
ylabel('g(t) --->')
%% calculate laplace f(t) and g(t) and plot
F = laplace(f);
G = laplace(g);
subplot(2,4,5)
fplot(F)
xlabel('s --->')
ylabel('F(s) --->')
subplot(2,4,7)
fplot(G)
xlabel('s --->')
ylabel('G(s) --->')
```

Graph :



A. From plots 1 and 2, it is evident that both functions *f* and *g* are identical.
B. From plots 3 and 4, it can be proved that laplace transforms of both *f* and *g* are equal.

```
>> lab5_2

F =

-(exp(-3*s) - 1)/s


G =

1/s - exp(-3*s)/s
```

Experiment 3:
Find the laplace transform of

$$f(t) = \begin{cases} 0, & 0 \leq t < 1 \\ t-1, & 1 \leq t < 2 \\ 0, & 2 \leq t \end{cases}$$

Code:

```
syms t
f = (t-1)*heaviside(t-1) + (1-t)*heaviside(t-2);
laplace(f)
```

Solution:

```
>> lab5_3

ans =

exp(-s)/s^2 - (exp(-2*s)*(s + 1))/s^2
```

Experiment 4:
Find the inverse laplace of

- $F(s) = \frac{1}{s}$

  Code :

  ```
  syms s
  F = 1/s;
  ilaplace(F)
  ```

Output:

```
>> lab5_4i

ans =

1
```

- $F(s) = \frac{10}{s^2+25} + \frac{4}{s-3}$

Code :

```
syms s
F = 10/(s*s + 25) + 4/(s-3);
ilaplace(F)
```

Output :

```
>> lab5_4ii

ans =

4*exp(3*t) + 2*sin(5*t)
```

- $F(s) = \frac{e^{-3s}(2s+7)}{s^2+16}$

Code:

```
syms s
F = exp(-3*s)*(2*s + 7)/(s^2 + 16);
ilaplace(F)
```

Output :

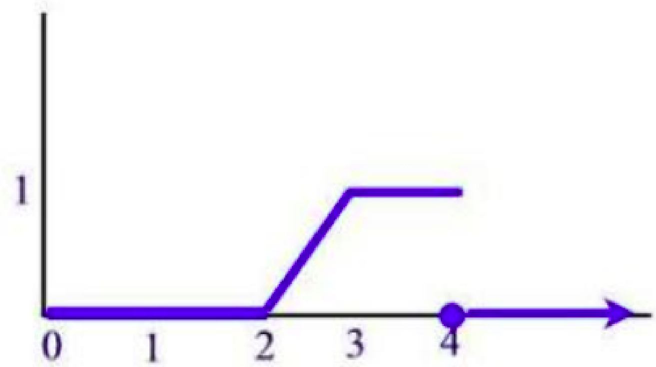
```
>> lab5_4iii

ans =

2*heaviside(t - 3)*cos(4*t - 12) + (7*heaviside(t - 3)*sin(4*t - 12))/4
```

- $$F(s) = \frac{s^2+5s-3}{(s^2+16)(s-2)}$$

  Code:
  ```
  syms s
  F = (s^2 + 5*s - 3)/((s^2 + 16)*(s - 2));
  ilaplace(F)
  ```
  Output :
  ```
  >> lab5_4iv

  ans =

  (9*cos(4*t))/20 + (11*exp(2*t))/20 + (59*sin(4*t))/40
  ```

Experiment 5:

Find the laplace transform of



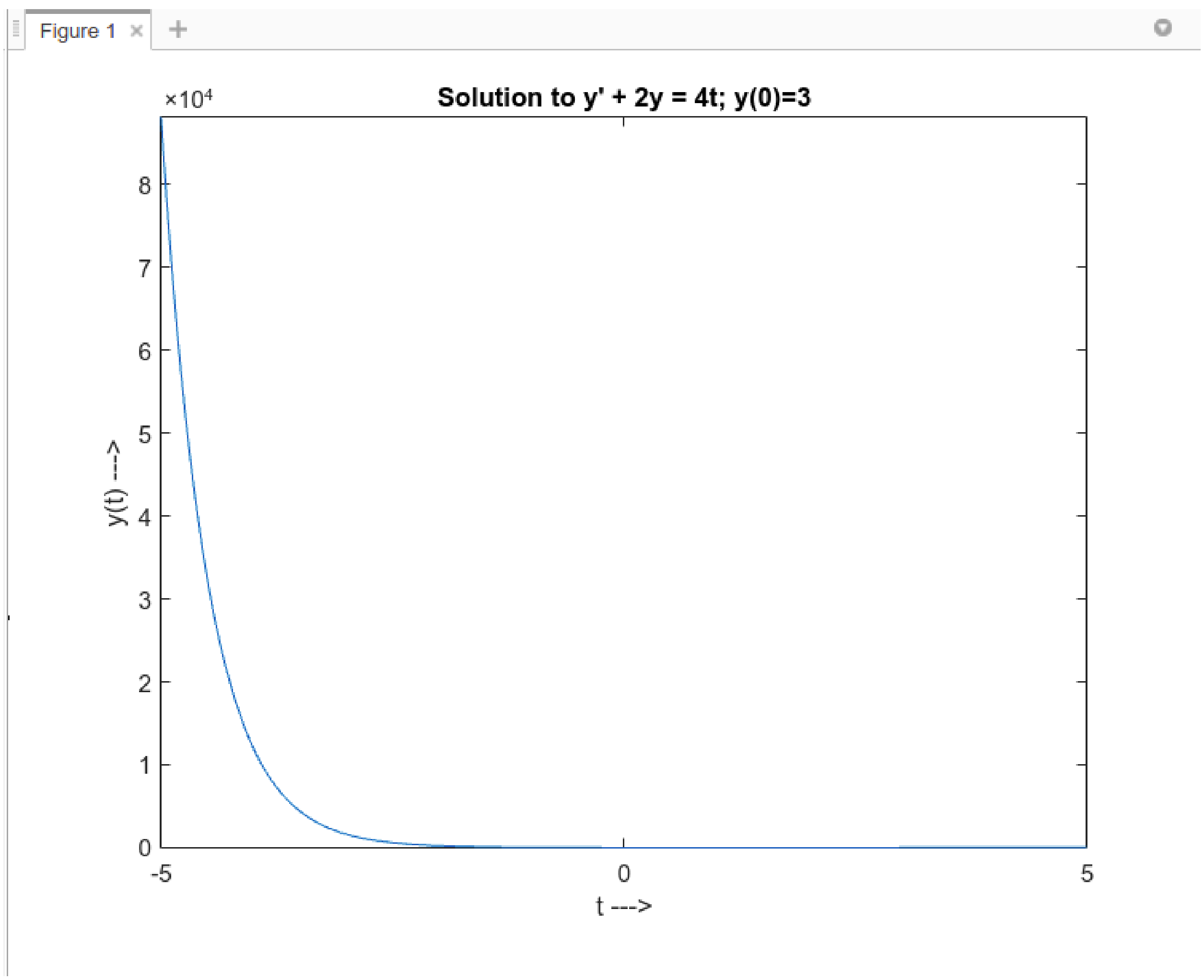
Code:
```
syms t
f = (t-2)*heaviside(t-2) + (2-t)*heaviside(t-4);
laplace(f)
```
Solution:
```
>> lab5_5

ans =

exp(-2*s)/s^2 - (exp(-4*s)*(2*s + 1))/s^2
```

Experiment 6:
Solve the initial value problem using Laplace transform.

- $y' + 2y = 4t, y(0) = 3$

Code:
```
%% y' + 2y = 4t; y(0)=3
syms s t Y
f = 4*t;
F = laplace(f);
Y1 = s*Y -3;
Sol = solve(Y1 + 2*Y - F, Y);
y = ilaplace(Sol)
fplot(y)
xlabel('t --->')
ylabel('y(t) --->')
title("Solution to y' + 2y = 4t; y(0)=3")
```

Graph and solution:



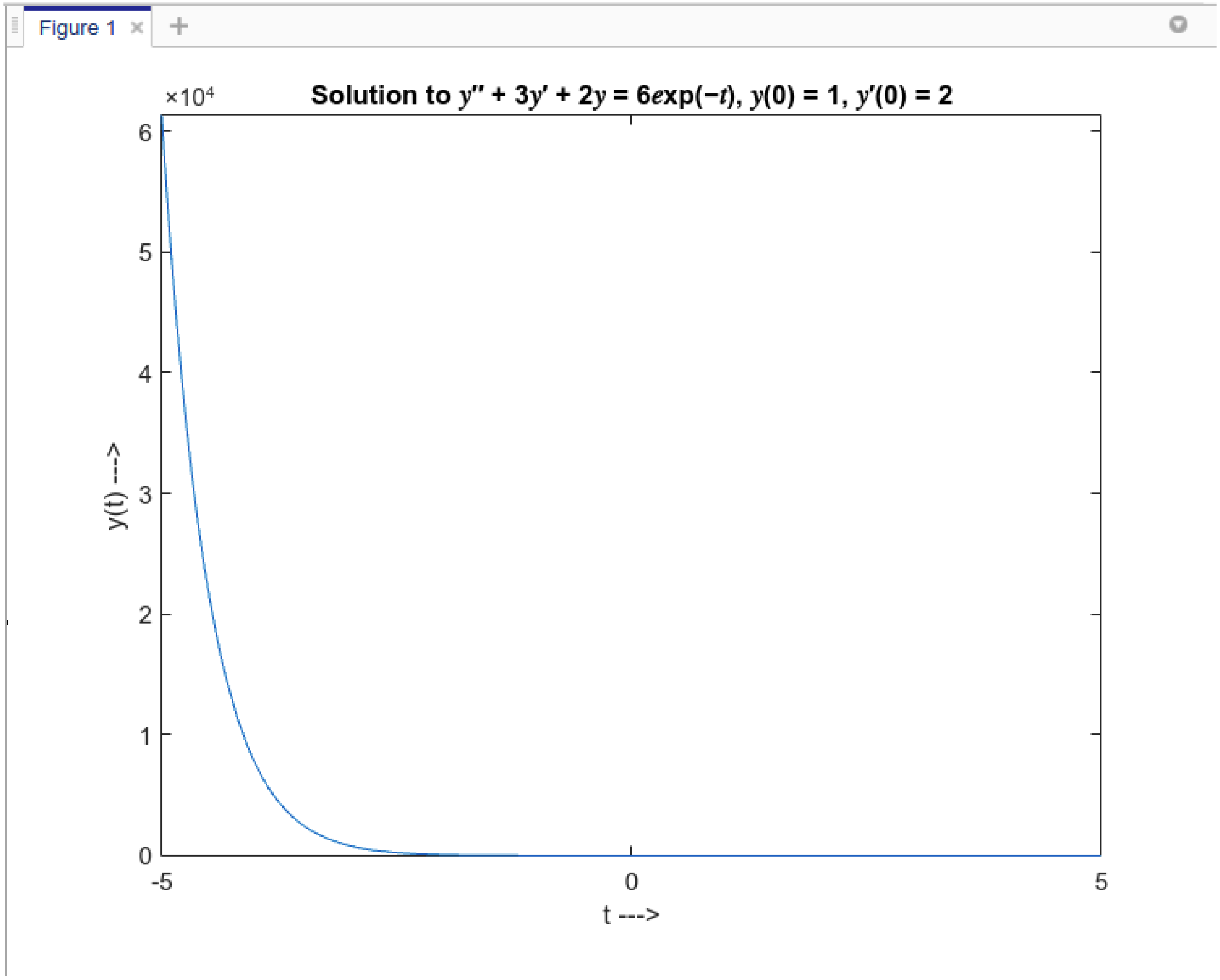
```
>> lab5_6i

y =

2*t + 4*exp(-2*t) - 1
```

- $y'' + 3y' + 2y = 6e^{-t}, y(0) = 1, y'(0) = 2$

Code:

```
% y'' + 3y' + 2y = 6e-t, y(0) = 1, y'(0) = 2
syms s t Y
f = 6*exp(-t);
F = laplace(f);
Y1 = s*Y - 1;
Y2 = s*Y1 - 2;
sol = solve(Y2 + 3*Y1 + 2*Y - F, Y);
y = ilaplace(sol)
fplot(y)
xlabel('t --->')
ylabel('y(t) --->')
title("Solution to y'' + 3y' + 2y = 6exp(-t), y(0) = 1, y'(0) = 2")
```

Graph and solution :




```
>> lab5_6ii

y =

3*exp(-2*t) - 2*exp(-t) + 6*t*exp(-t)
```

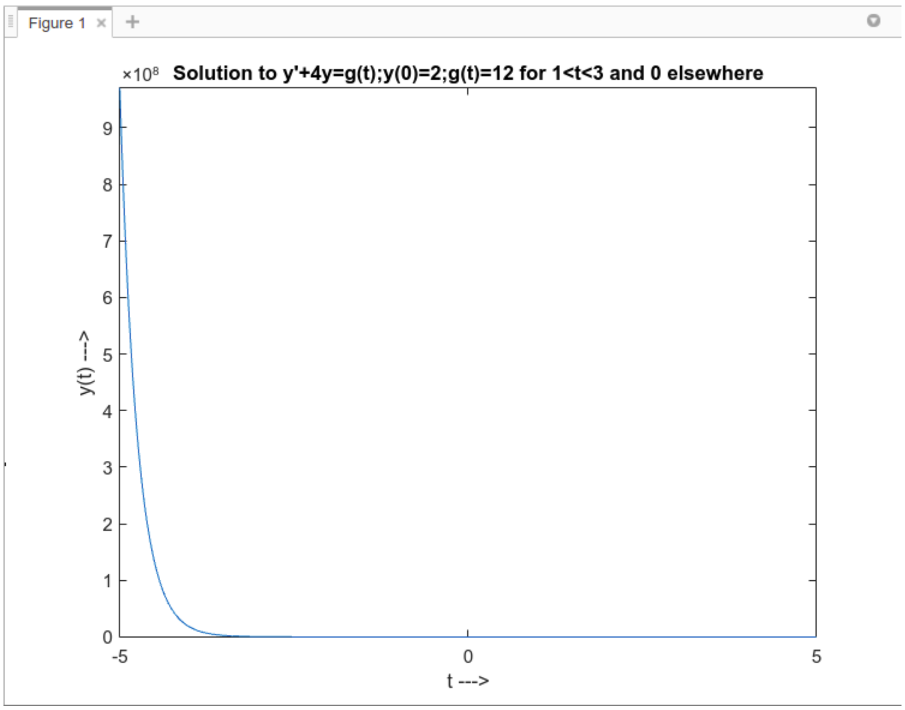
- $y' + 4y = g(t), y(0) = 2, where\ g(t) = 12\ if\ (1 < t < 3)\ else\ 0$

Code:

```
% y' + 4y = g(t), y(0) = 2, where g(t) = 12 if (1 < t < 3) else 0
syms s t Y
f = (12*heaviside(t-1) - 12*heaviside(t-3)) ;
F = laplace(f);
Y1 = s*Y - 2;
sol = solve(Y1 + 4*Y - F, Y);
y = ilaplace(sol)
fplot(y)
```

```
xlabel('t --->')
ylabel('y(t) --->')
title("Solution to y'+4y=g(t);y(0)=2;g(t)=12 for 1<t<3 and 0
elsewhere")
```

Graph and solution:




```
>> lab5_6iii

y =

2*exp(-4*t) - 12*heaviside(t - 1)*(exp(4 - 4*t)/4 - 1/4) + 12*heaviside(t - 3)*(exp(12 - 4*t)/4 - 1/4)
```

Experiment 7:
Verify that multiplication in s domain is equivalent to convolution in time domain.
Code:

```
syms t s
func=@(p) p;
f=func(t);
f1=func(s-t);
F=int(f*f1,0,'s');
G=ilaplace(laplace(f)*laplace(f));
t=1:100;
s=t;
subplot(2,4,1)
plot(t,subs(F))
xlabel('t --->')
ylabel('F --->')
```

```
title('Convolution')
subplot(2,4,3)
plot(t,subs(G))
xlabel('s --->')
ylabel('G --->')
title('Product of laplace')
```

Graph :