classmate

Date
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Experiment - 5

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ECE1018 - Lab
L21 + L22

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1. Fourier series of a square wave

Period = 2ms

Peak-to-peak value = 2V

Average value = 0V

$$x(t) = 4/\pi \sum_{n=0}^{\infty} 1/(2n+1) \sin((2n+1) 2\pi f_0 t)$$

2. Fourier series of a sawtooth wave

$$x(t) = 2/\pi \sum_{n=01}^{\infty} (-1)^{n+1} (\sin n\omega t / n)$$

3. Fourier series of a triangular wave

$$x(t) = 8/\pi^2 \sum_{n=0}^{\infty} (-1)^n [\sin((2n+1)\omega t)/(2n+1)^2]$$

4. Find the approximate CTFS harmonic function of a periodic signal $x(t)$ where

$$x(t) = \sqrt{1-t^2}, \quad -1 \leq t \leq 1$$

Should not use built-in functions

13/9/19

Experiment - 6

→ To solve a second order linear differential equation, using laplace transform (13/9/19)

- Laplace transform of a function $f(t)$ is defined as,

$$F(s) = L\{f(t)\}$$
$$= \int_0^\infty e^{-st} f(t)\, dt, \quad (1)$$

provided the integral exists

- laplace(f) : To find laplace transform of any function f. Return is default in 's'
- ilaplace(f) : To find inverse laplace transform of function f. Return is default in 't'
- heaviside(t-a) : To input heaviside's unit step function $u_n(t) = h(t-a)$
- dirac(t-a) : To input dirac delta function δ
- laplace(f,t,w) : Second and third variables are the input variable and output variable respectively.

1. Find the laplace transform of

$$f(t) = \begin{cases} t^2 & t<2 \\ t-1 & 2<t<3 \\ 7 & t>3 \end{cases}$$

2. Find the inverse laplace transform of e^{-s}

3 Solve the initial value problem

$$\frac{d^2y}{dt^2} + 2\frac{dy}{dt} + 5y = e^{-t}\sin t$$

where $y(0) = 0 \qquad y'(0) = 1$

14/9/19

ans Screenshots 5, 6, 7

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1. Answer

Enter function of t:

(t^2) * (heaviside (t) - heaviside (t-2)) +
(t-1) * (heaviside (t-2) - heaviside (t-3)) +
7 * heaviside (t-3)

L{f(t)} = (7 * exp(-3*s))/s - (4*exp(-2*s))/s -
(4 * exp(-2*s))/s^2 - (2 * exp(-2*s))/s^3 +
2/s^3 - (exp(-3*s) * (2*s - exp(s) - s*exp(s)+1))/s^2

$$= 7e^{-3s}/s - 4e^{-2s}/s - 4e^{-2s}/s^2 - 2e^{-2s}/s^3 + 2/s^3 - (e^{-3s}[2s - e^s - se^s + 1])/s^2$$

Experiment – 5

Code:

Editor - C:\Users\18BIS0043\Documents\MATLAB\E5.m

E5.m

```
clc
clear all
close all
syms c1 c2 x m
Co = input('Enter the coefficients [a,b,c]: ');
f = input('Enter the RHS function f(x): ');
a = Co(1);
b = Co(2);
c = Co(3);
aux = a*m^2 + b*m + c;
m = solve(aux);
D = b^2 - 4*a*c;

```

Editor - C:\Users\18BIS0043\Documents\MATLAB\E5.m

E5.m

```

if(D>0)
    % Roots are real and different
    y1 = exp(m(1)*x);
    y2 = exp(m(2)*x);
elseif(D==0)
    % Roots are real and equal
    y1 = exp(m(1)*x);
    y2 = exp(m(1)*x);
else
    % Roots are imaginary
    alpha = real(m(1));
    beta = imag(m(1));
    y1 = exp(alpha*x)*cos(beta*x);
    y2 = exp(alpha*x)*sin(beta*x);
end
```

```
29
30 -    yc = c1*y1 + c2*y2; %CF
31 -    fx = f/a;
32 -    W = y1*diff(y2,x) - y2*diff(y1,x);
33 -    u = int(-y2*fx/W,x);
34 -    v = int(y1*fx/W,x);
35 -    yp = y1*u + y2*v; %PI
36 -    y_g = yc+yp;
37 -    ch = input('Enter "1" if initial conditions, else "2": ');
38
```

```
38
39 -    if(ch==1)
40 -        cn = input('Enter the initial conditions [x0,y(x),Dy(x)]: ');
41 -        dy_g = diff(y_g);
42 -        eq1 = (subs(y_g,x,cn(1))-cn(2));
43 -        eq2 = (subs(dy_g,x,cn(1))-cn(3));
44 -        [c1 c2] = solve(eq1,eq2);
45 -        y = simplify(subs(y_g));
46 -        disp('The Complete solution is: ');
47 -        disp(y);
48 -        ezplot(y,[cn(1),cn(1)+2]);
49 -        grid on;
50 -    else
51 -        y = simplify(y_g);
52 -        disp('The General solution is: ');
53 -        disp(y);
54 -    end
55
```

Answer - 2:

Command Window

New to MATLAB? See resources for Getting Started.

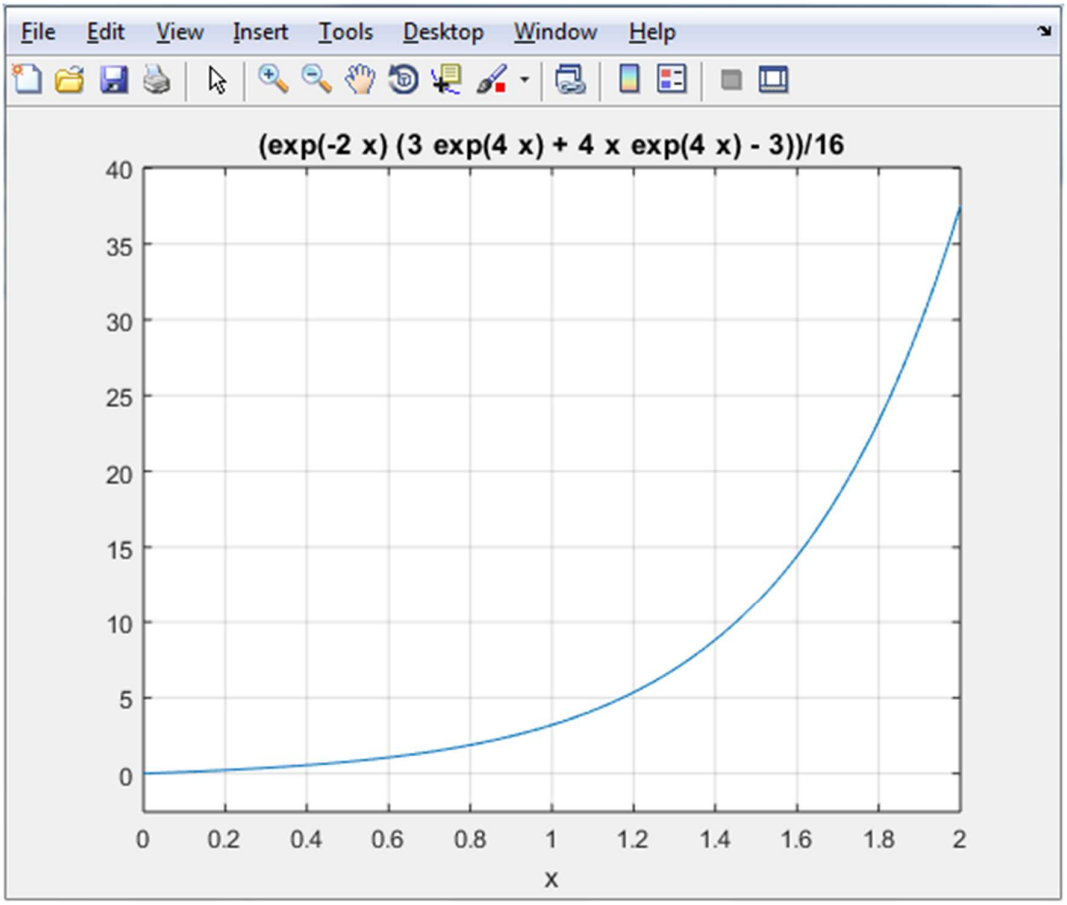
```
Enter the coefficients [a,b,c]: [1 0 1]
Enter the RHS function f(x): sec(x)*tan(x)
Enter "1" if initial conditions, else "2": 2
The General solution is:
(log(tan(x)^2 + 1)*sin(x))/2 - sin(x) + c1*cos(x) - c2*sin(x) + x*cos(x)

fx >>
```

Answer - 1:

```
Command Window
Enter the coefficients [a,b,c]: [1 0 -4]
Enter the RHS function f(x): exp(2*x);
Enter "1" if initial conditions, else "2": 1
Enter the initial conditions [x0,y(x),Dy(x)]: [0 0 1]
The Complete solution is:
(exp(-2*x)*(3*exp(4*x) + 4*x*exp(4*x) - 3))/16

fx >>
```



Experiment – 6

Code – Laplace transform with example:

Editor - C:\Users\18BIS0043\Documents\MATLAB\E6.m

E6.m

```
1 -    clear all
2 -    clc
3 -    syms t
4 -    f = input('Enter the function of t: ');
5 -    F = laplace(f);
6 -    disp(['L{f(t)} = ',char(F)]);
```

Command Window

New to MATLAB? See resources for Getting Started.

```
Enter the function of t: sin(t)
L{f(t)} = 1/(s^2 + 1)
fx >>
```

Code – Inverse Laplace transform with example:

Editor - C:\Users\18BIS0043\Documents\MATLAB\E6_2.m

E6.m | E6_2.m

```
1 -    clear all
2 -    clc
3 -    syms s
4 -    f = input('Enter the function of s: ');
5 -    F = ilaplace(f);
6 -    disp(['L^-1{F(s)} = ',char(F)]);
```

Command Window

New to MATLAB? See resources for Getting Started.

```
Enter the function of s: 6/(s^3+2*s^2-s-2)
L^-1{F(s)} = 2*exp(-2*t) - 3*exp(-t) + exp(t)
fx >>
```

Answer – 1:

Editor - C:\Users\18BIS0043\Documents\MATLAB\E6.m

E6.m

```
1 -    clear all
2 -    clc
3 -    syms t
4 -    f = input('Enter the function of t: ');
5 -    F = laplace(f);
6 -    disp(['L{f(t)} = ',char(F)]);
```

Command Window

New to MATLAB? See resources for Getting Started.

```
Enter the function of t: (t^2)*(heaviside(t)-heaviside(t-2)) + (t-1)*(heaviside(t-2)-heaviside(t-3)) + 7*heaviside(t-3)
L{f(t)} = (7*exp(-3*s))/s - (4*exp(-2*s))/s - (4*exp(-2*s))/s^2 - (2*exp(-2*s))/s^3 + 2/s^3 - (exp(-3*s)*(2*s - exp(s) - s*exp(s) + 1))/s^2
fx >>
```

Solution written in notebook also...

Answer – 2:

Editor - C:\Users\18BIS0043\Documents\MATLAB\E6_2.m

E6.m | E6_2.m

```
1 -    clear all
2 -    clc
3 -    syms s
4 -    F = input('Enter the function of s: ');
5 -    f = ilaplace(F);
6 -    disp(['L^-1{F(s)} = ',char(f)]);
```

Command Window

New to MATLAB? See resources for Getting Started.

```
Enter the function of s: exp(-s)
L^-1{F(s)} = dirac(t - 1)
fx >>
```

Answer – 3:

Editor - C:\Users\18BIS0043\Documents\MATLAB\E6_3.m

E6.m | E6_2.m | E6_3.m

```
clear all
clc
syms s t y(t) Y
dy(t) = diff(y(t),1);
d2y(t) = diff(y(t),2);
F = input('Enter the coefficients in the form [a,b,c]: ');
A = F(1);
B = F(2);
C = F(3);


non = input('Enter the Non-homogenous part f(x): ');
eq1 = A*d2y(t) + B*dy(t) + C*y(t) - non;
LT = laplace(eq1,t,s);
Initial = input('Enter the initial condition in the form [y(0),Dy(0)]: ');
y0  = Initial(1);
dy0 = Initial(2);


 LT = subs(LT,{'laplace(y(t),t,s)','y(0)','D(y)(0)'},{Y,y0,dy0});
 final_eq = collect(LT,Y);
 Y = simplify(solve(final_eq,Y));
 yt = simplify(ilaplace(Y,s,t));
 disp('The solution of the differential equation y(t) = ');
 disp(yt);
 ezplot(yt,[y0,y0+2]);
 grid on;
```

I/O:

```
Command Window
New to MATLAB? See resources for Getting Started.

Enter the coefficients in the form [a,b,c]: [1 2 5]
Enter the Non-homogenous part f(x): exp(-t)*sin(t)
Enter the initial condition in the form [y(0),Dy(0)]: [0 1]
The solution of the differential equation y(t) =
(exp(-t)*(sin(2*t) + sin(t)))/3

fx >>
```

Graph: