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Section:	BCE – 4A
Course:	Signals & Systems
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Report:	12

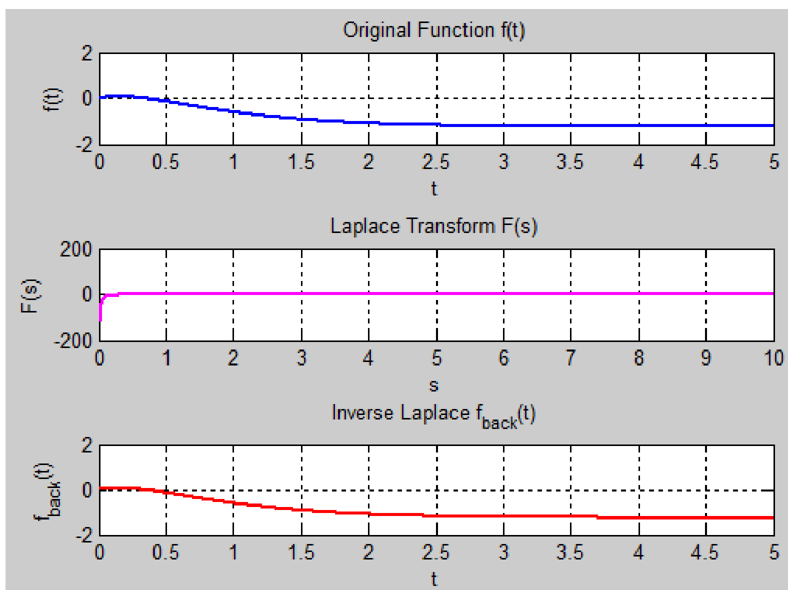
LAB 12

Open ended lab

Task 01: Compute the unilateral Laplace transform of the function $f(t) = -1.25 + 3.5te^{-2t} + 1.25e^{-2t}$**. Also evaluate the inverse Laplace transform of your result.**

```
syms t s
f=-1.25+3.5*t*exp(-2*t)+1.25*exp(-2*t);
F_s=laplace(f,t,s);
disp('Laplace Transform F(s):');pretty(F_s)
f_t_back=ilaplace(F_s,s,t);
disp('Inverse Laplace Transform f(t):');pretty(f_t_back)
f_num=matlabFunction(f);
f_back_num=matlabFunction(f_t_back);
F_num=matlabFunction(F_s);
t_vals=linspace(0,5,500);
s_vals=linspace(0.01,10,500);
f_vals=f_num(t_vals);
f_back_vals=f_back_num(t_vals);
F_vals=F_num(s_vals);
figure;
subplot(3,1,1);
plot(t_vals,f_vals,'b','LineWidth',2);
xlabel('t');ylabel('f(t)');
title('Original Function f(t)');
grid on;
subplot(3,1,2);
plot(s_vals,F_vals,'m','LineWidth',2);
xlabel('s');ylabel('F(s)');
title('Laplace Transform F(s)');
grid on;
subplot(3,1,3);
plot(t_vals,f_back_vals,'r','LineWidth',2);
xlabel('t');ylabel('f_{back}(t)');
title('Inverse Laplace f_{back}(t)');
grid on;
```

```
>> TASK_1
Laplace Transform F(s):
    5             7          5
--------- + ---------- - ---
4 (s + 2)             2   4 s
             2 (s + 2)

Inverse Laplace Transform f(t):
exp(-2 t) 5   t exp(-2 t) 7   5
----------- + ------------- - -
     4              2         4
```

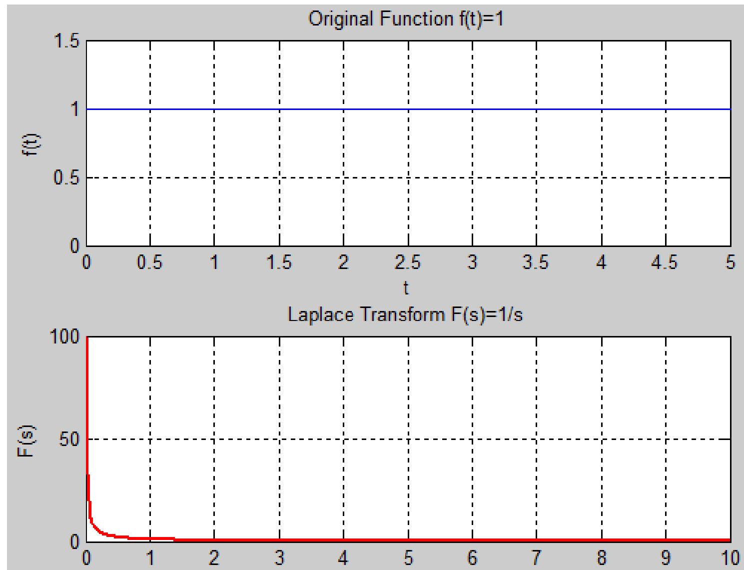


Task 02: Compute the unilateral Laplace transform of the function $f(t) = 1$**.**

```
syms t s
```

```
f(t)=sym(1);
F_s=laplace(f,t,s);
disp('Laplace Transform of f(t)=1 is:');pretty(F_s)
f_num=matlabFunction(f);
F_num=matlabFunction(F_s);
t_vals=linspace(0,5,500);
s_vals=linspace(0.01,10,500);
f_vals=f_num(t_vals);
F_vals=F_num(s_vals);
figure;
subplot(2,1,1);
plot(t_vals,f_vals,'b','LineWidth',2);
xlabel('t');ylabel('f(t)');
title('Original Function f(t)=1');
ylim([0 1.5]);
grid on;
subplot(2,1,2);
plot(s_vals,F_vals,'r','LineWidth',2);
xlabel('s');ylabel('F(s)');
title('Laplace Transform F(s)=1/s');
grid on;
```

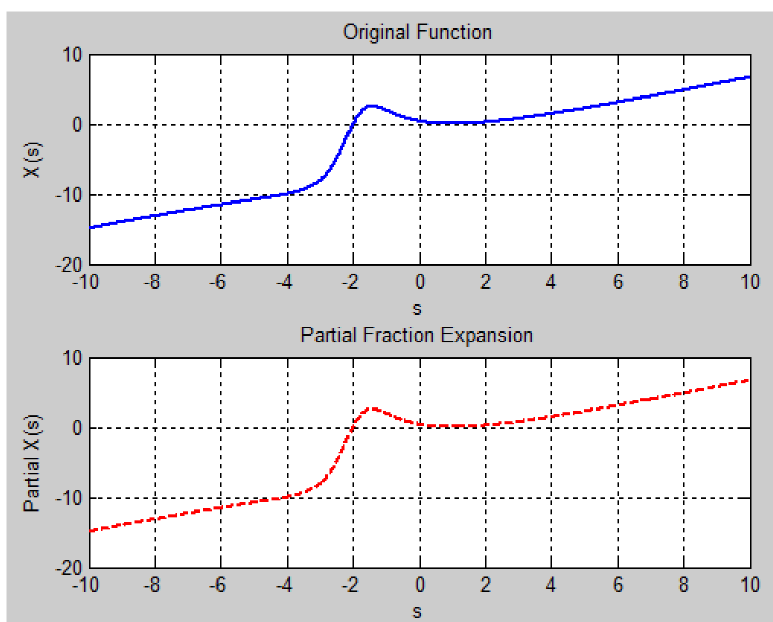
```
>> TASK_2
Laplace Transform of f(t)=1 is:
1
-
s
```



Task 03: Express in the partial fraction form the signal

$$X(s) = \frac{s^3 - 3s + 2}{s^2 + 4s + 5}$$

```
syms s
num=s^3-3*s+2;
den=s^2+4*s+5;
[q,r]=quorem(num,den,s);
disp('Quotient:');pretty(q)
p=feval(symengine,'partfrac',r/den,s);
disp('Partial Fraction Expansion of
remainder:');pretty(p)
X_s=q+p;
disp('Final Partial Fraction Form of X(s):');
pretty(X_s)
X_num=matlabFunction(num/den);
X_pf=matlabFunction(X_s);
s_vals=linspace(-10,10,1000);
X_vals=X_num(s_vals);
X_pf_vals=X_pf(s_vals);
figure;
```



```
subplot(2,1,1);
plot(s_vals,X_vals,'b','LineWidth',2);
xlabel('s');ylabel('X(s)');
title('Original Function');
grid on;
subplot(2,1,2);
plot(s_vals,X_pf_vals,'r--','LineWidth',2);
xlabel('s');ylabel('Partial X(s)');
title('Partial Fraction Expansion');
grid on;
```

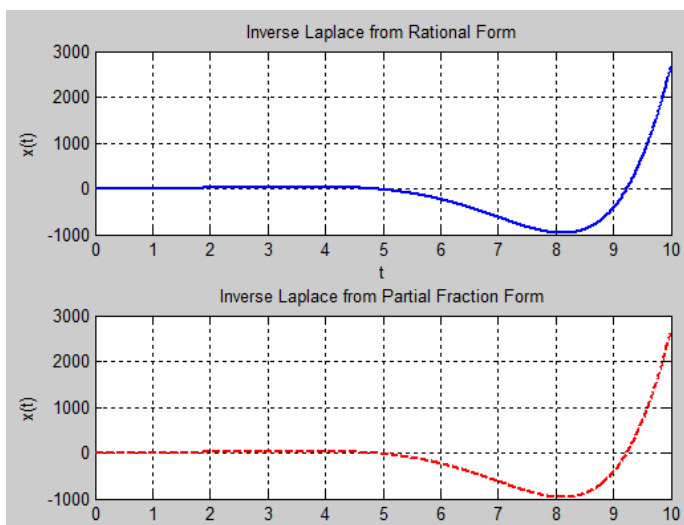
```
>> TASK_3
Quotient:
s - 4

Partial Fraction Expansion of remainder:
  8 s + 22
------------
 2
s  + 4 s + 5

Final Partial Fraction Form of X(s):
      8 s + 22
s + ------------ - 4
     2
    s  + 4 s + 5
```

Task 04: Express in the partial fraction form the signal

$$X(s) = \frac{s^2 + 5s + 4}{s^4 + 1}$$

Verify your result by computing the inverse Laplace transform from both forms (partial fraction and rational) and plot both of the results.

```
syms s t
num=s^2+5*s+4;
den=s^4+1;
Xs=num/den;
Xs_pf=feval(symengine,'partfrac',Xs,s);
disp('Partial Fraction Expansion of X(s):');pretty(Xs_pf)
xt_rational_expr=ilaplace(Xs,s,t);
xt_partial_expr=ilaplace(Xs_pf,s,t);
disp('Inverse Laplace from Rational Form:');pretty(xt_rational_expr)
disp('Inverse Laplace from Partial Fraction Form:');pretty(xt_partial_expr)
xt_rational_fun=matlabFunction(real(xt_rational_expr),'Vars',t);
xt_partial_fun=matlabFunction(real(xt_partial_expr),'Vars',t);
t_vals=linspace(0,10,1000);
y_rational=xt_rational_fun(t_vals);
y_partial=xt_partial_fun(t_vals); figure;
subplot(2,1,1)
plot(t_vals,y_rational,'b','LineWidth',2)
title('Inverse Laplace from Rational Form')
xlabel('t')
ylabel('x(t)') grid on
subplot(2,1,2)
plot(t_vals,y_partial,'r--','LineWidth',2)
title('Inverse Laplace from Partial Fraction Form')
xlabel('t')
ylabel('x(t)'); grid on
```

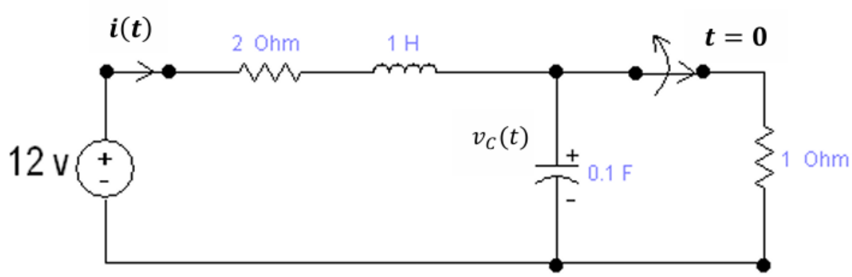


```
>> TASK_4
Partial Fraction Expansion of X(s):
 2
s  + 5 s + 4
------------
    4
   s  + 1

Inverse Laplace from Rational Form:
                                             / sqrt(2) t \     / sqrt(2) t \
                                     sqrt(2) cos| --------- | sinh| --------- | 3
  / sqrt(2) t \     / sqrt(2) t \                \     2     /     \     2     /
sin| --------- | sinh| --------- | 5 - --------------------------------------------
  \     2     /     \     2     /                          2

         / sqrt(2) t \    / sqrt(2) t \
    sqrt(2) cosh| --------- | sin| --------- | 5
                \     2     /    \     2     /
  + --------------------------------------------
                       2

Inverse Laplace from Partial Fraction Form:
                                             / sqrt(2) t \     / sqrt(2) t \
                                     sqrt(2) cos| --------- | sinh| --------- | 3
  / sqrt(2) t \     / sqrt(2) t \                \     2     /     \     2     /
sin| --------- | sinh| --------- | 5 - --------------------------------------------
  \     2     /     \     2     /                          2

         / sqrt(2) t \    / sqrt(2) t \
    sqrt(2) cosh| --------- | sin| --------- | 5
                \     2     /    \     2     /
  + --------------------------------------------
                       2
```

In-Lab Open ended Tasks

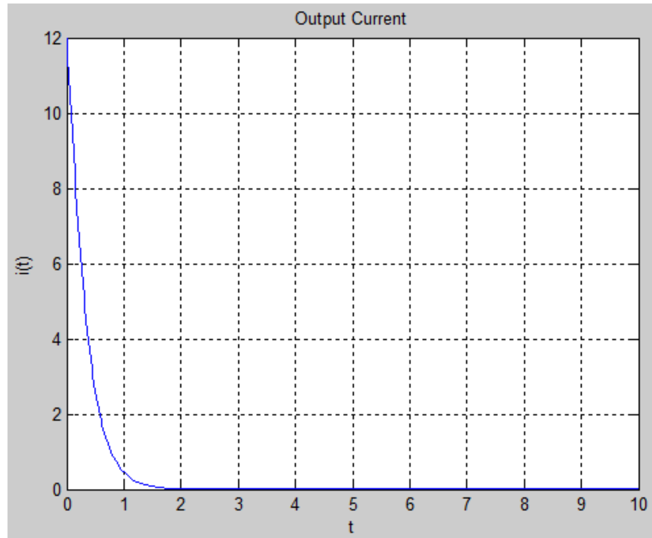
Task 01: Examine the network shown in figure 12.1 below. Assume the network is in steady state prior to $t = 0$.

- **I.** **Plot the output current $i(t)$, for $t > 0$**
- **II.** **Determine whether the system is stable or not?**




```
syms s t
R1 = 2
R2 = 1
L = 1
C = 0.1
```

```
V = 12
Z1 = R1 + L*s
Z2 = 1 / (s*C)
Zp = (Z2 * R2) / (Z2 + R2)
I_s = V / (Z1 + Zp)
i_t = ilaplace(I_s, s, t)
i_func = matlabFunction(i_t)
fplot(i_func, [0 10])
xlabel('t')
ylabel('i(t)')
title('Output Current')
grid on
s = tf('s')
Z1 = R1 + L*s
Z2 = 1 / (s*C)
Zp = (Z2 * R2) / (Z2 + R2)
Zt = Z1 + Zp
I = V / Zt
disp('Poles:')
pole(I_s)
if isstable(I)
   disp('System is STABLE')
else
   disp('System is UNSTABLE')
end
```

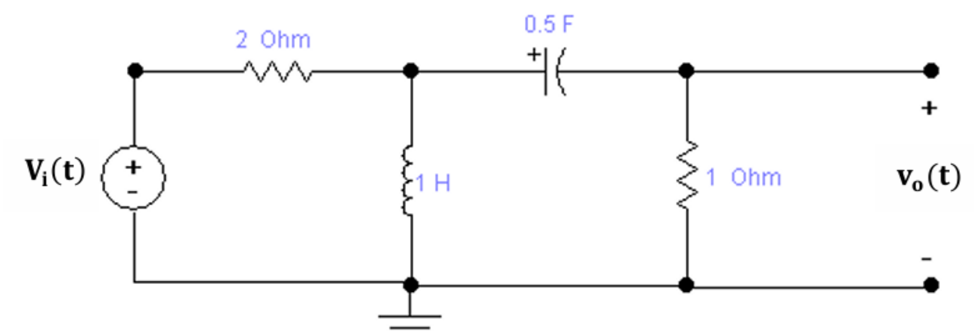



```
Poles:

ans =

         0
   -8.4495
   -3.5505

System is UNSTABLE
```

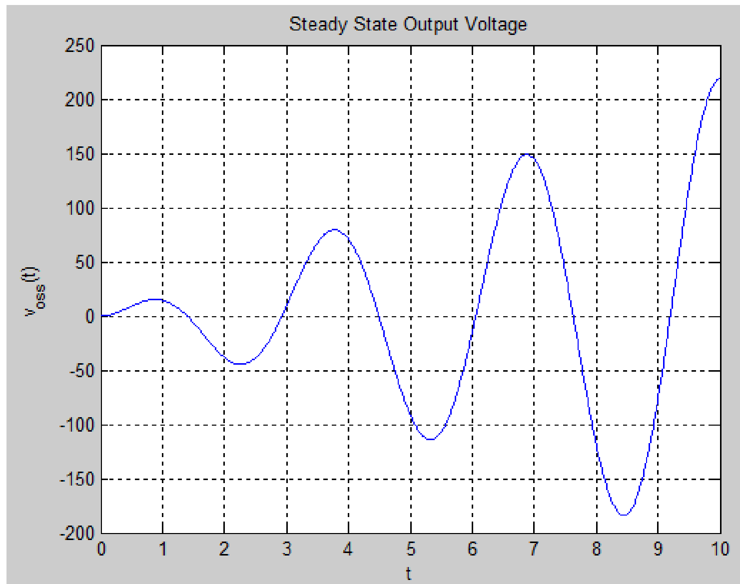
Task 02: For the circuit shown in figure 12.2, the input voltage is $V_i(t) = 10\cos(2t)\,u(t)$

I. **Plot the steady state output voltage $v_{oss}(t)$ for $t > 0$ assuming zero initial conditions.**

II. **Determine whether the system is stable or not?**



```
s = tf('s')
R1 = 2
R2 = 1
L = 1
C = 0.5
Vi = 10 * s / (s^2 + 4)
Z_L = L * s
Z_C = 1 / (C * s)
Z1 = R1 + Z_L
Z2 = Z_C + R2
Z_total = Z1 + Z2
Vout = (Z2 / Z_total) * Vi
t = linspace(0, 10, 1000)
v_out = lsim(Vout, cos(2*t)*10, t)
plot(t, v_out)
xlabel('t')
ylabel('v_o_s_s(t)')
title('Steady State Output Voltage')
grid on
disp('Poles:')
pole(Vout)
if isstable(Vout)
   disp('System is STABLE')
else
   disp('System is UNSTABLE')
end
```




```
Poles:

ans =

   0.0000 + 0.0000i
   0.0000 + 2.0000i
   0.0000 - 2.0000i
  -2.0000 + 0.0000i
  -1.0000 + 0.0000i

System is UNSTABLE
```

Critical Analysis

This lab involved solving problems using Laplace transforms, partial fractions, and RLC circuit analysis in MATLAB.

MATLAB made it easy to handle both symbolic and numerical tasks. It helped quickly find and check Laplace transforms and their inverses, and also showed results through plots. Partial fractions were done easily using built-in functions. In circuit analysis, MATLAB allowed us to model and simulate current and voltage responses. We also checked system stability by finding poles. Overall, MATLAB made solving and understanding these topics much simpler and clearer.

Lab Assessment		
Lab Task Evaluation	**/6**	**/10**
Lab Report	**/4**	
Instructor Signature and Comments		