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MAT2002 – Applications of Differential and Difference Equations
Experiment 3A, 3B
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Index of Solved Problems:

Experiment 3A: Variation of parameters method

Exercise Problem 1:

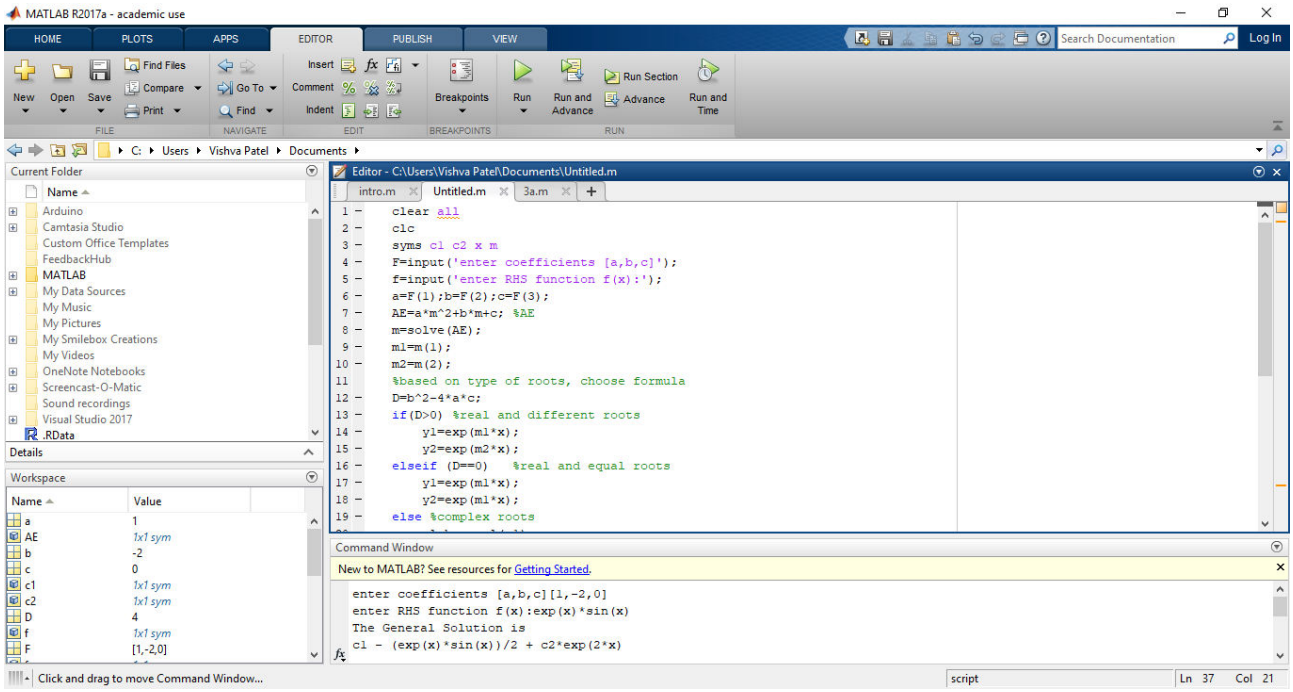
Find the general solution of the differential equation $y'' - 2y' = ex \sin x$

MATLAB Code:

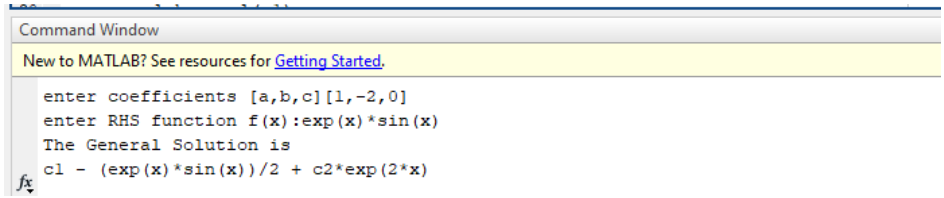
```
clear all
clc
syms c1 c2 x m
F=input('enter coefficients [a,b,c]');
f=input('enter RHS function f(x):');
a=F(1);b=F(2);c=F(3);
AE=a*m^2+b*m+c; %AE
m=solve(AE);
m1=m(1);
m2=m(2);
%based on type of roots, choose formula
D=b^2-4*a*c;
if(D>0) %real and different roots
    y1=exp(m1*x);
    y2=exp(m2*x);
elseif (D==0)   %real and equal roots
    y1=exp(m1*x);
    y2=exp(m1*x);
else %complex roots
    alpha=real(m1);
```

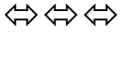
```
    beta=imag(m1);
    y1=exp(alpha*x)*cos(beta*x);
    y2=exp(alpha*x)*sin(beta*x);
end
yc=c1*y1+c2*y2;    %CF

%to find PI by method of  variation of paraeters
fx=f/a;
W=y1*diff(y2,x)-y2*diff(y1,x);
u=int(-y2*fx/W,x);
v=int(y1*fx/W,x);
yp=y1*u+y2*v;
y_gen=yc+yp;
y=simplify(y_gen);
disp('The General Solution is ');
disp(y);
```

Screenshots of MATLAB work area:



Output:





Exp 3B: Solve LDE by Laplace transforms

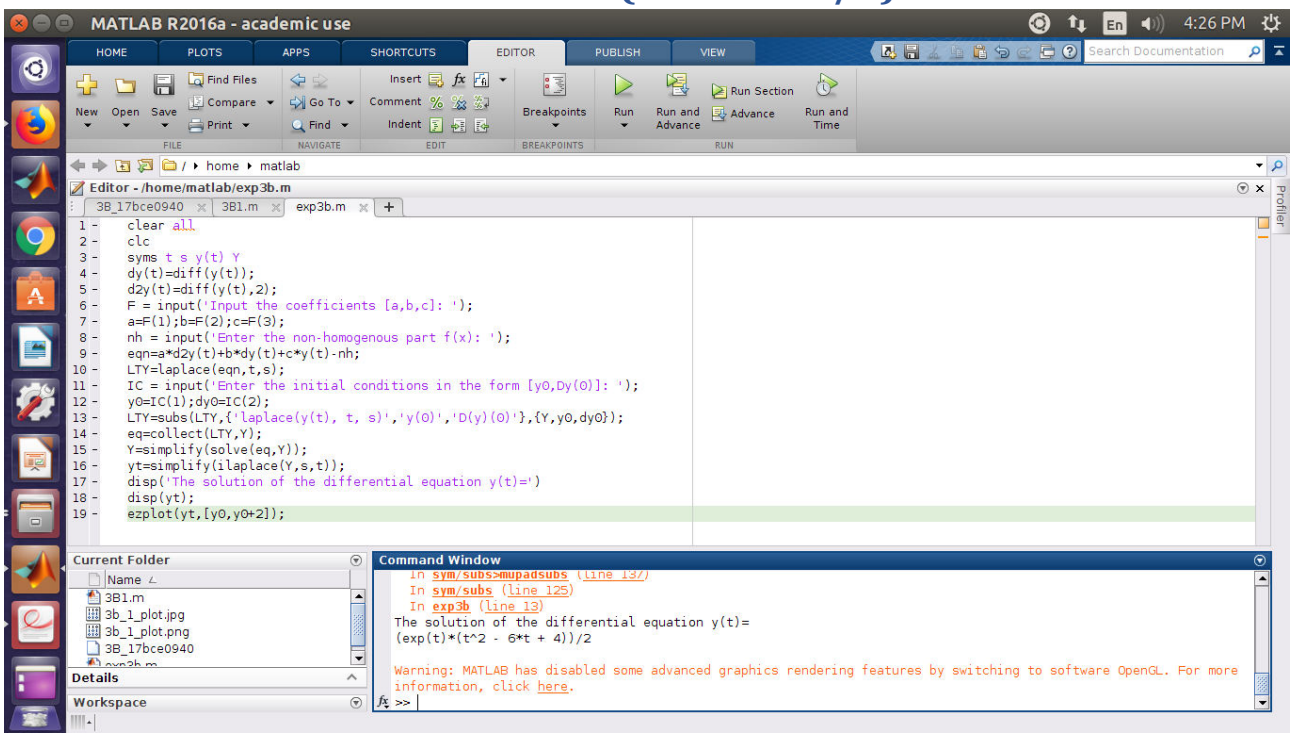
Exercise problem: 1

Solve $y'' - 2y' + y = e^t$, subject to $y(0) = 2$, $y'(0) = -1$

Matlab code:

```
clear all
clc
syms t s y(t) Y
dy(t)=diff(y(t));
d2y(t)=diff(y(t),2);
F = input('Input the coefficients [a,b,c]: ');
a=F(1);b=F(2);c=F(3);
nh = input('Enter the non-homogenous part f(x): ');
eqn=a*d2y(t)+b*dy(t)+c*y(t)-nh;
LTY=laplace(eqn,t,s);
IC = input('Enter the initial conditions in the form [y0,Dy(0)]: ');
y0=IC(1);dy0=IC(2);
LTY=subs(LTY,{'laplace(y(t), t, s)','y(0)','D(y)(0)'},{Y,y0,dy0});
eq=collect(LTY,Y);
Y=simplify(solve(eq,Y));
yt=simplify(ilaplace(Y,s,t));
disp('The solution of the differential equation y(t)=')
disp(yt);
ezplot(yt,[y0,y0+2]);
```

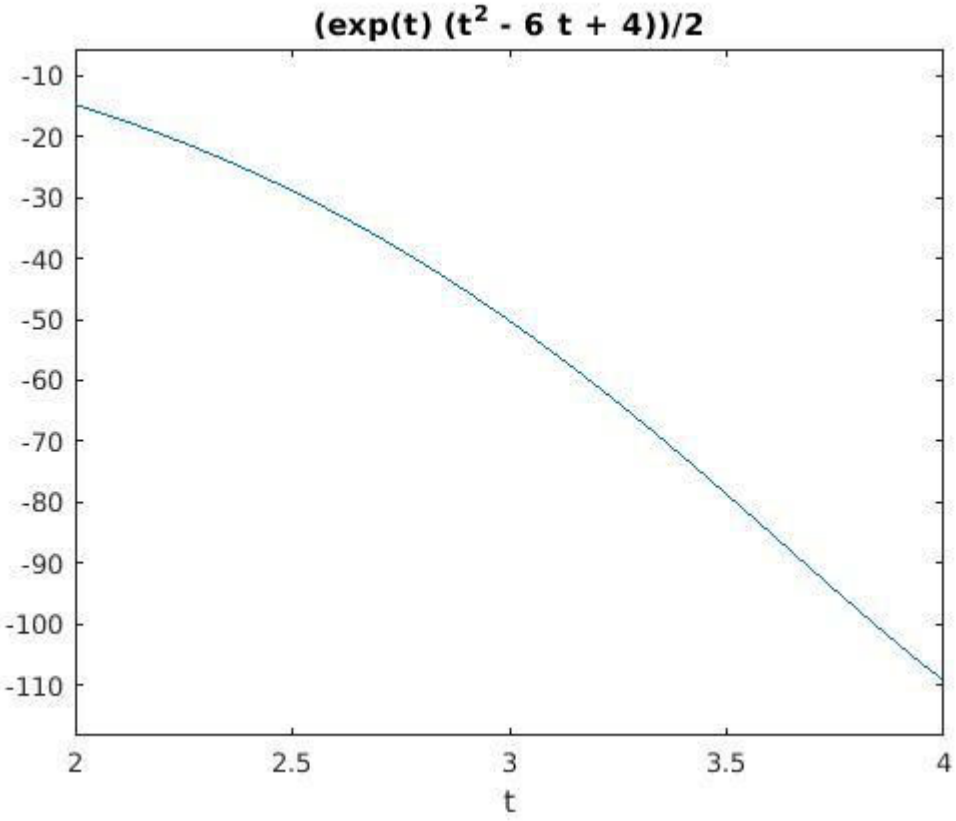
MATLAB work area screenshot (code and i/o):



Output:

```
Command Window
The solution of the differential equation y(t)=
(exp(t)*(t^2 - 6*t + 4))/2

Warning: MATLAB has disabled some advanced graphics rendering features by switching to
information, click here.
fx >>
```

Plot:



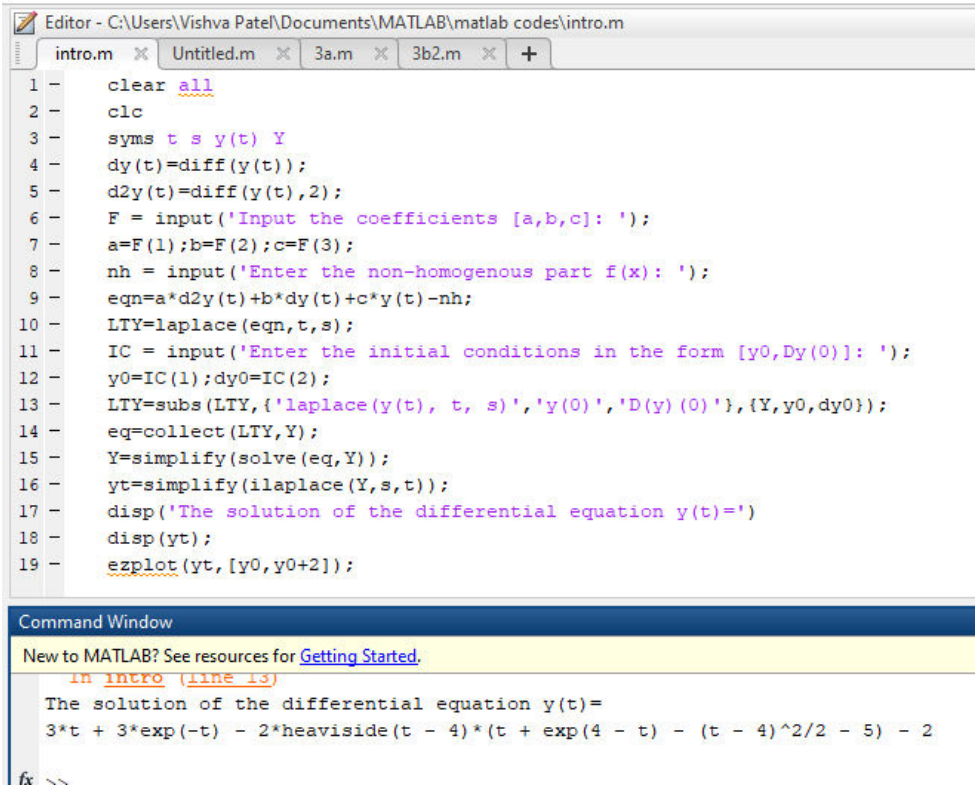
Exercise problem 2

Solve $y'' + y = f(t),\ y(0) = 1,\ y'(0) = 0$ where $f(t) = \begin{cases} 3, & t \le 4 \\ 2t - 5, & t > 4 \end{cases}$.

MATLAB code:

```
clear all
clc
syms t s y(t) Y
dy(t)=diff(y(t));
d2y(t)=diff(y(t),2);
F = input('Input the coefficients [a,b,c]: ');
a=F(1);b=F(2);c=F(3);
nh = input('Enter the non-homogenous part f(x): ');
eqn=a*d2y(t)+b*dy(t)+c*y(t)-nh;
LTY=laplace(eqn,t,s);
IC = input('Enter the initial conditions in the form [y0,Dy(0)]: ');
y0=IC(1);dy0=IC(2);
LTY=subs(LTY,{'laplace(y(t), t, s)','y(0)','D(y)(0)'},{Y,y0,dy0});
eq=collect(LTY,Y);
Y=simplify(solve(eq,Y));
yt=simplify(ilaplace(Y,s,t));
disp('The solution of the differential equation y(t)=')
disp(yt);
ezplot(yt,[y0,y0+2]);
```

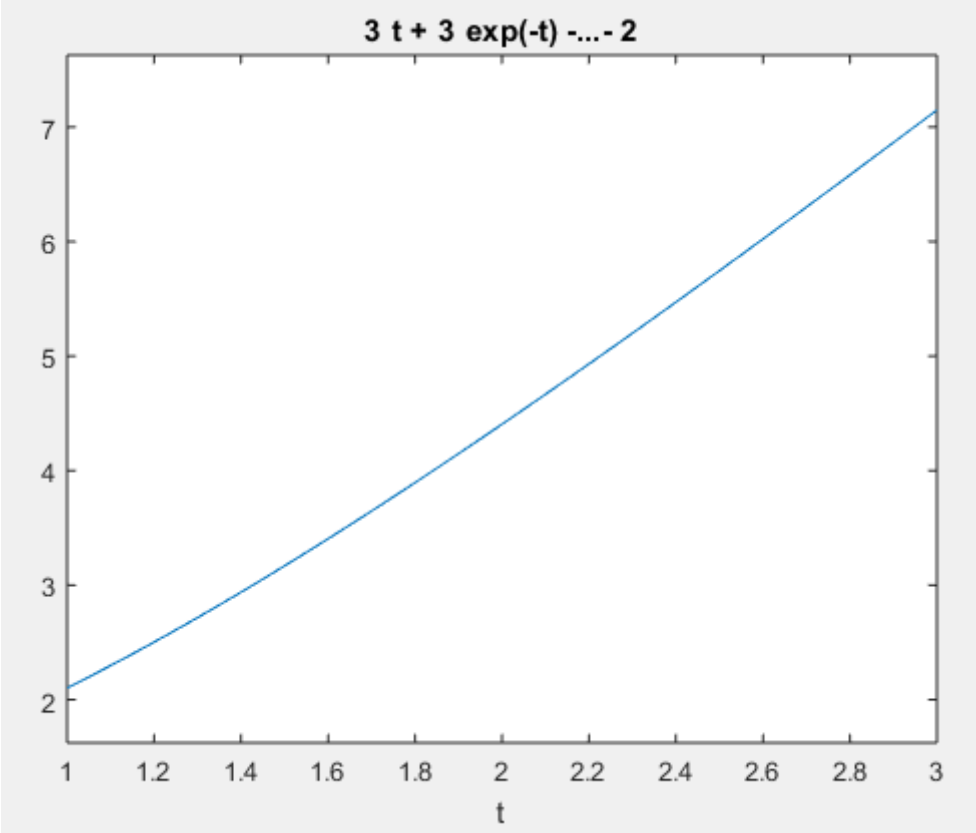
MATLAB work area screenshot:



Output:

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

Input the coefficients [a,b,c]: [1,1,0]
Enter the non-homogenous part f(x): 3*(heaviside(t)-heaviside(t-4))+(2*t-5)*(heaviside(t-4))
Enter the initial conditions in the form [y0,Dy(0)]: [1,0]

The solution of the differential equation y(t)=
3*t + 3*exp(-t) - 2*heaviside(t - 4)*(t + exp(4 - t) - (t - 4)^2/2 - 5) - 2

>>
```

Plot:



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