MAT 2002

MATLAB

Lab Assessment – 3

L29+L30

FALL SEMESTER 2020-21

by

SHARADINDU ADHIKARI

19BCE2105

Question 1

Problem:

Solve the initial value problem and plot the graph of solution y for $0 \leq x \leq 2$.

$y'' + 4y' + 20y = 23\sin x - 15\cos x, \quad y(0) = 0, \quad y'(0) = -1$

Code in MATLAB Editor:

```
clear all
close all
clc
syms c1 c2 x m
F=input('Enter the coefficients [a,b,c]: ');
f=input('Enter the RHS function f(x): ');
a=F(1);b=F(2);c=F(3);
AE=a*m^2+b*m+c; % Auxilliary Equation
m=solve(AE);
m1=m(1); m2=m(2);
D=b^2-4*a*c;
if(D>0) % Roots are real and different
y1=exp(m1*x);y2=exp(m2*x);
elseif (D==0)% Roots are real and equal
y1=exp(m1*x);y2=x*exp(m1*x);
else % Roots are complex
alfa=real(m1);beta=imag(m1);
y1=exp(alfa*x)*cos(beta*x);
y2=exp(alfa*x)*sin(beta*x);
end
yc=c1*y1+c2*y2; % Complimentary Solution
%%% Particular Integral by Method of variation of parameters.
fx=f/a;
W=y1*diff(y2,x)-y2*diff(y1,x); %%% Wronskian%%%
u=int(-y2*fx/W,x);
v=int(y1*fx/W,x);
yp=y1*u+y2*v; %%%Particular Integral%%%
y_gen=yc+yp; %%%General Solution%%%
check=input('If the problem has initial conditions then enter 1 else
enter 2: ');
if(check==1)
cn=input('Enter the initial conditions [x0, y(x0), Dy(x0)]:');
dy_gen=diff(y_gen);
eq1=(subs(y_gen,x,cn(1))-cn(2));
eq2=(subs(dy_gen,x,cn(1))-cn(3));
[c1 c2]=solve(eq1,eq2);
y=simplify(subs(y_gen));
disp('The complete solution is');
disp(y);
ezplot(y, [cn(1),cn(1)+2]);
else
y=simplify(y_gen);
disp('The General Solution is ');
disp(y);
end
```

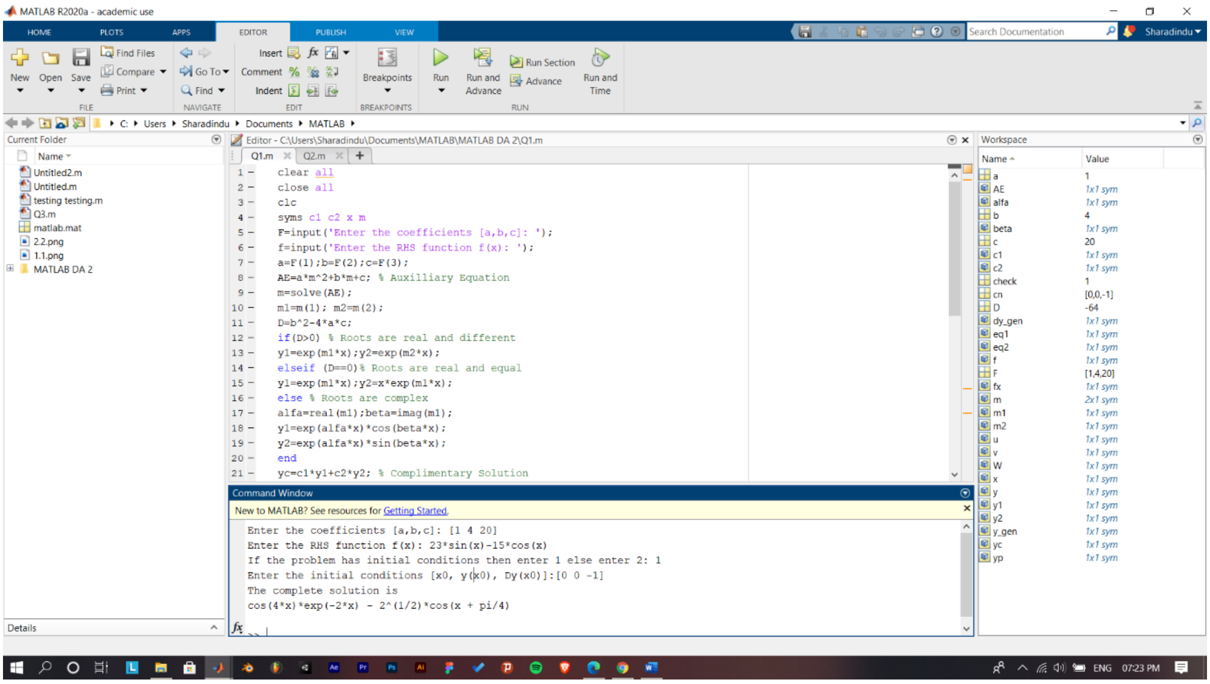
Input in Command Window:

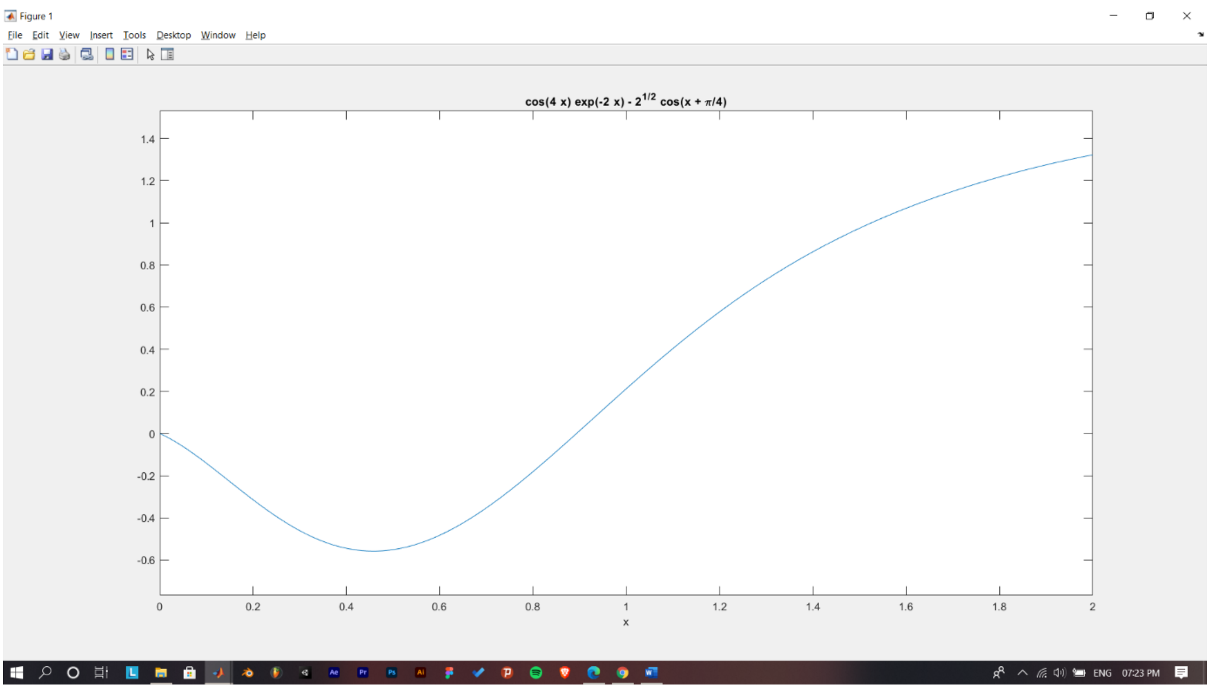
```
Enter the coefficients [a,b,c]: [1 4 20]
Enter the RHS function f(x): 23*sin(x)-15*cos(x)
If the problem has initial conditions then enter 1 else enter 2: 1
Enter the initial conditions [x0, y(x0), Dy(x0)]:[0 0 -1]
```

Output in Command Window:

```
The complete solution is
cos(4*x)*exp(-2*x) - 2^(1/2)*cos(x + pi/4)
```

Screenshots (with Graph):





Question 2

Problem:

Find the current I(t) in an RLC circuit with $R = 11\ \Omega$, $L=0.1$ H, $C=10^{-2}$ F, which is connected to a source of voltage $E(t) = 100 \sin 400t$. Assume that the current and the charge are zero when $t=0$, plot the graph for charge and current for $0 \le t \le 3$.

Code in MATLAB Editor:

```
clear all
close all
clc
syms c1 c2 x m
F=input('Enter the coefficients [a,b,c]: ');
f=input('Enter the RHS function f(x): ');
a=F(1);b=F(2);c=F(3);
AE=a*m^2+b*m+c; % Auxilliary Equation
m=solve(AE);
m1=m(1); m2=m(2);
D=b^2-4*a*c;
if(D>0) % Roots are real and different
y1=exp(m1*x);y2=exp(m2*x);
elseif (D==0)% Roots are real and equal
y1=exp(m1*x);y2=x*exp(m1*x);
else % Roots are complex
alfa=real(m1);beta=imag(m1);
y1=exp(alfa*x)*cos(beta*x);
y2=exp(alfa*x)*sin(beta*x);
end
yc=c1*y1+c2*y2; % Complimentary Solution
%%% Particular Integral by Method of variation of parameters.
fx=f/a;
W=y1*diff(y2,x)-y2*diff(y1,x); %%% Wronskian%%%
u=int(-y2*fx/W,x);
v=int(y1*fx/W,x);
yp=y1*u+y2*v; %%%Particular Integral%%%
y_gen=yc+yp; %%%General Solution%%%
check=input('If the problem has initial conditions then enter 1 else
enter 2: ');
if(check==1)
cn=input('Enter the initial conditions [x0, y(x0), Dy(x0)]:');
dy_gen=diff(y_gen);
eq1=(subs(y_gen,x,cn(1))-cn(2));
eq2=(subs(dy_gen,x,cn(1))-cn(3));
[c1 c2]=solve(eq1,eq2);
y=simplify(subs(y_gen));
disp('The complete solution is');
disp(y);
ezplot(y, [cn(1),cn(1)+2]);
else
y=simplify(y_gen);
disp('The General Solution is ');
disp(y);
end
```

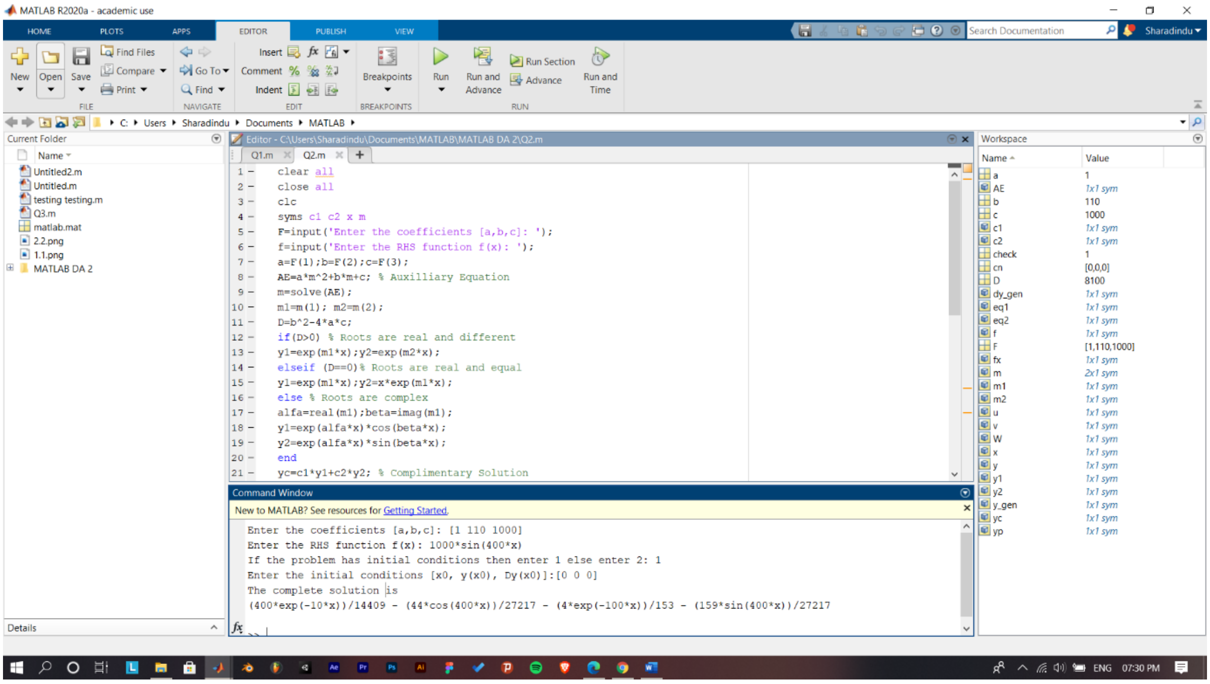
Input in Command Window:

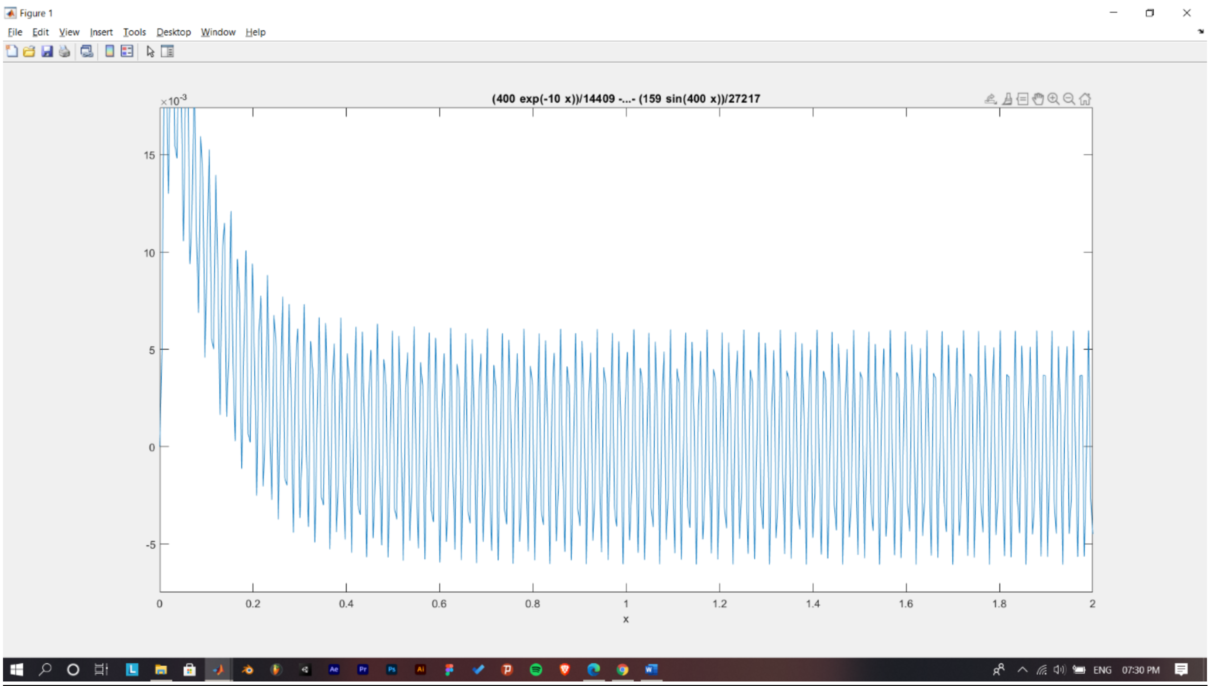
```
Enter the coefficients [a,b,c]: [1 110 1000]
Enter the RHS function f(x): 1000*sin(400*x)
If the problem has initial conditions then enter 1 else enter 2: 1
Enter the initial conditions [x0, y(x0), Dy(x0)]:[0 0 0]
```

Output in Command Window:

```
The complete solution is
(400*exp(-10*x))/14409 - (44*cos(400*x))/27217 - (4*exp(-100*x))/153
- (159*sin(400*x))/27217
```

Screenshots (with Graph):





Question 3

Problem:

Solve $y'' + 2\,y' + 10\,y = 1 + 5\,\delta\,(t-5), \quad y(0) = 1, \quad y'(0) = 2.$
Plot the graph of solution y.

Code in MATLAB Editor:

```
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-homogeneous 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), dy(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]);
```

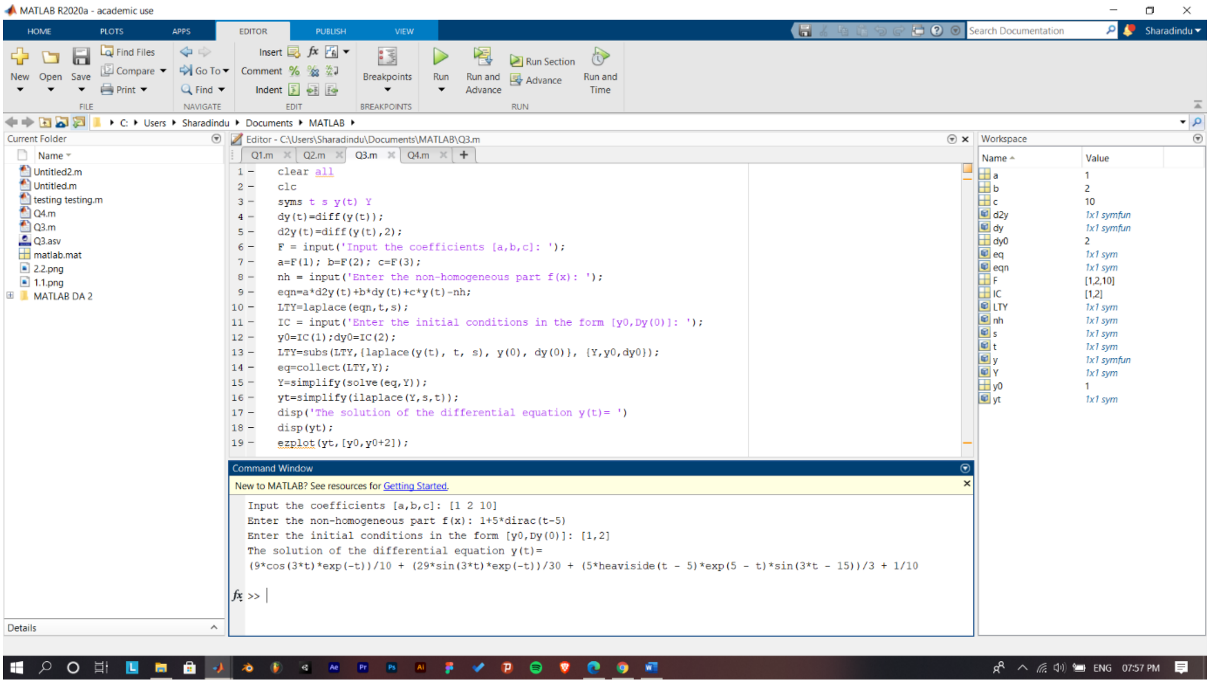
Input in Command Window:

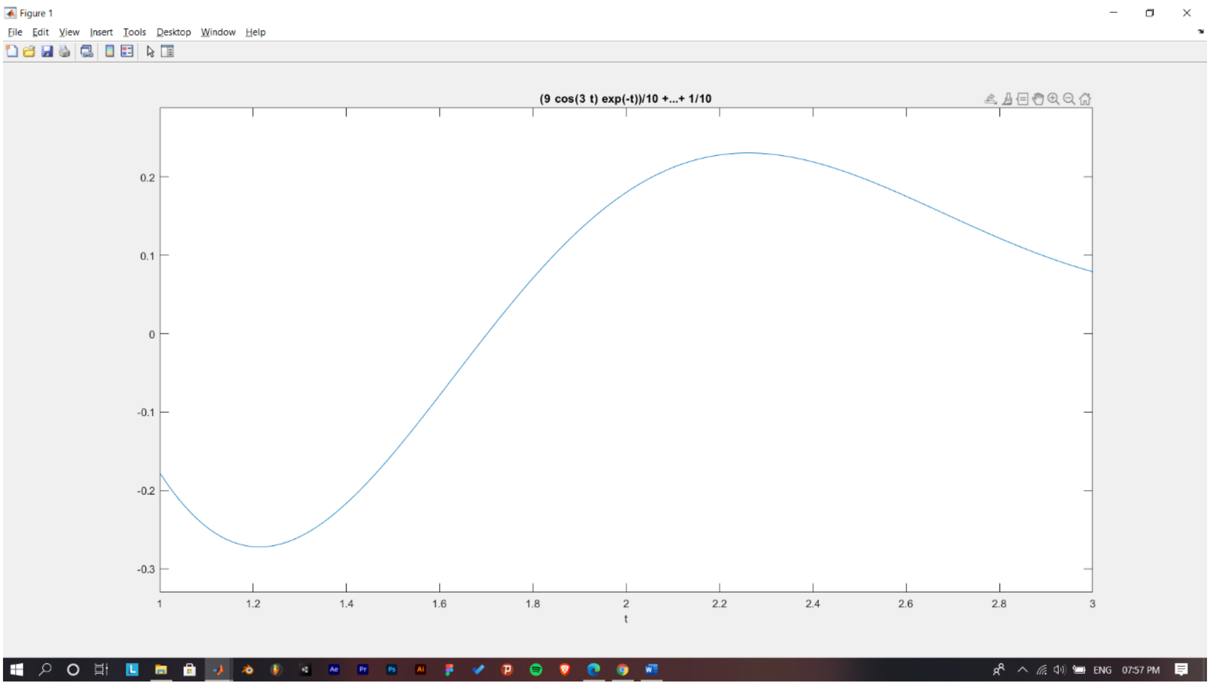
```
Input the coefficients [a,b,c]: [1 2 10]
Enter the non-homogeneous part f(x): 1+5*dirac(t-5)
Enter the initial conditions in the form [y0,Dy(0)]: [1,2]
```

Output in Command Window:

```
The solution of the differential equation y(t)=
(9*cos(3*t)*exp(-t))/10 + (29*sin(3*t)*exp(-t))/30 + (5*heaviside(t -
5)*exp(5 - t)*sin(3*t - 15))/3 + 1/10
```

Screenshots (with Graph):





Question 4

Problem:

Solve $y'' + y = f(t)$, $y(0) = 1$, $y'(0) = 0$, $where\ f(t) = 3\ \forall\, t \leq 4\ and\ 2t - 5\ \forall\ t > 4$. Plot the graph of solution y.

Code in MATLAB Editor:

```
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),dy(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]);
```

Input in Command Window:

```
Input the coefficients [a,b,c]: [1 0 1]
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]
```

Output in Command Window:

```
The solution of the differential equation y(t)=
2*t - 2*cos(t) - 2*sin(t) + 8*heaviside(t - 4)*(cos(t - 4) - 1) + 3
```

Screenshots (with Graph):