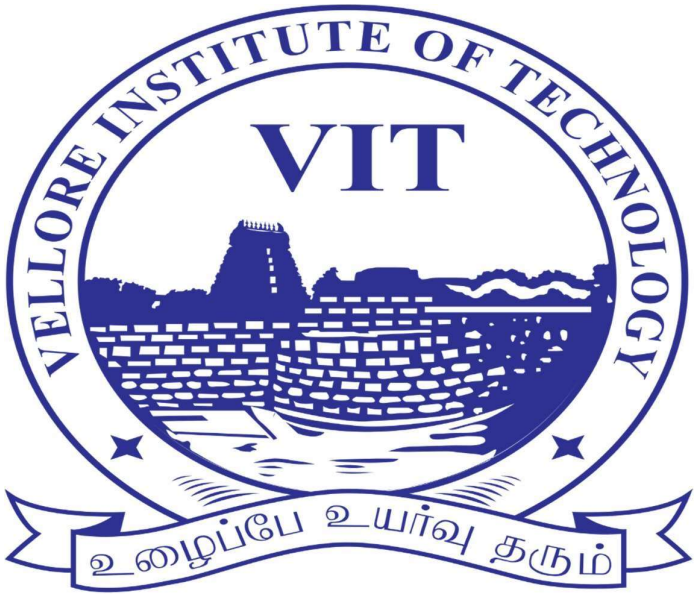

MAT 2002 – Application of Difference and Differential Equation

Fourier Series

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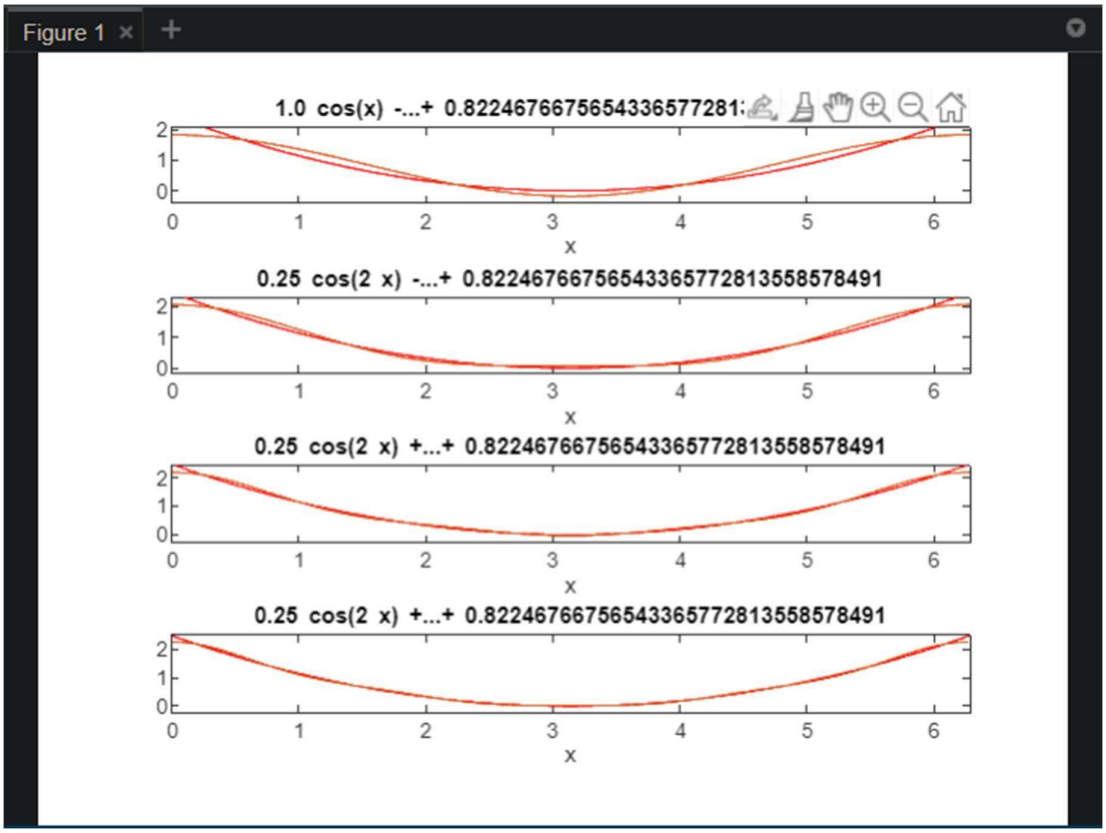
Code-

```
syms x
f=input('Enter the function in terms of x:')
L=input('Enter the lower limit of the domain')
U=input('Enter the upper limit of the domain') % (L,U)
L1=(U-L)/2;
disp('Enter value of N between 1 and 7')
N=input('Enter the number of terms N')
a_0=vpa((2/(U-L))*int(f,x,L,U),4); %
F_s=a_0/2;
for n=1:1:N
a(n)=vpa((2/(U-L))*int(f*cos((n*pi*x)/L1),x,L,U),4); %2/(U-L)=1/L1
b(n)=vpa((2/(U-L))*int(f*sin((n*pi*x)/L1),x,L,U),4);
F_s=F_s+a(n)*cos((n*pi*x)/L1)+b(n)*sin((n*pi*x)/L1) % F_s= a0/2+a1+b1 ; 2nd iteration: F_s= a0+a1+b1+a2+b2
subplot(N,1,n)
plot1=ezplot(f,[L,U]);
set(plot1,'color','r')
hold on
ezplot(F_s,[L,U])
end
```

1. Find the Fourier series of $f(x) = (\frac{\pi - x}{2})^2$, $0 \leq x \leq 2\pi$, taking number of terms $N = 4$.

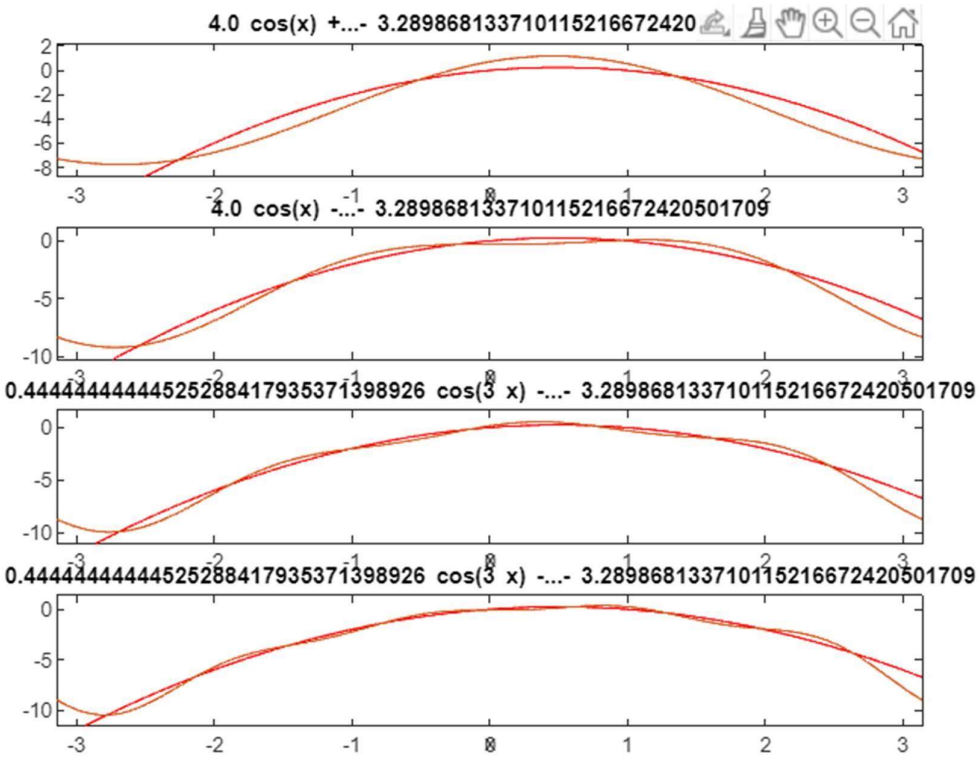
```
Command Window

F_s =

1.0*cos(x) - 0.0015926535893271420718519948422909*sin(x) + 0.822467667565433657728135585 78491


F_s =

0.25*cos(2*x) - 0.0007963267946635710359259974211 4544*sin(2*x) + 1.0*cos(x) - 0.0015926535893271420718519948422909*sin(x) +
0.822467667565433657728135585 78491


F_s =

0.25*cos(2*x) + 0.1111111111113132210448384284 9731*cos(3*x) - 0.0007963267946635710359259974211 4544*sin(2*x) -
0.0005308845297751219050041981972754*sin(3*x) + 1.0*cos(x) - 0.0015926535893271420718519948422909*sin(x) + 0.822467667565433657728135585 78491


F_s =

0.25*cos(2*x) + 0.1111111111113132210448384284 9731*cos(3*x) + 0.0625*cos(4*x) - 0.0007963267946635710359259974211 4544*sin(2*x) -
0.0005308845297751219050041981972754*sin(3*x) - 0.0003981633973317855179629987 1057272*sin(4*x) + 1.0*cos(x) -
0.0015926535893271420718519948422909*sin(x) + 0.822467667565433657728135585 78491
```



2. Find the Fourier series of $f(x) = x - x^2$, $-\pi \leq x \leq \pi$, taking number of terms $N = 4$.

Output-

```
Command Window

     4


F_s =

4.0*cos(x) + 2.0*sin(x) - 3.289868133710115216672420501709


F_s =

4.0*cos(x) - 1.0*sin(2*x) - 1.0*cos(2*x) + 2.0*sin(x) - 3.289868133710115216672420501709


F_s =

0.44444444444525288417935371398926*cos(3*x) - 1.0*cos(2*x) - 1.0*sin(2*x) + 0.66666666666787932626903057098389*sin(3*x) + 4.0*cos(x) + 2.0*sin(x) -
3.289868133710115216672420501709


F_s =

0.44444444444525288417935371398926*cos(3*x) - 1.0*cos(2*x) - 0.25*cos(4*x) - 1.0*sin(2*x) + 0.66666666666787932626903057098389*sin(3*x) - 0.5*sin(4*x)
+ 4.0*cos(x) + 2.0*sin(x) - 3.289868133710115216672420501709
```



CODE-

```
syms t
n= input('Enter the number of data points n : '); % number of x values
x_0= input('Enter the starting value of x : '); % x_1 [x(1), x(n)] x_1=x_0+s, x_2=x_1+s= x_0+2s
count = input('type 0 if the unit of x is deg. type a non-zero number otherwise');
s=input('Enter the length of the spacing between successive values of x :');
n1= input('Enter the number of harmonic of the series n1 : '); % a_1, a_2, a_{n1}
for i=1:n
x(i)=x_0+(i-1)*s;
end % x_1, x_2, x_3, .... , x_n x_2-x_1=s
if (count == 0)
x=x*pi/180;
s=s*pi/180;
end
y = input('Enter the y values (as a row vector) :') % y=[y_1 y_2 y_3 y_n]
if y(1)== y(n)
l=0.5*(x(n)-x(1)); % l=pi if it is degree function f has period 2pi
else
l=0.5*(x(n)+s-x(1));
end
a_0= (2/n)*sum(y)
for i=1:n1
yc=y.*cos(i*pi*x/l);
ys=y.*sin(i*pi*x/l);
a(i)=(2/n)*sum(yc);
b(i)=(2/n)*sum(ys);
end
F_s=a_0/2;
for i=1:n1
subplot(n1,1,i)
plot(x,y,'r*');
hold on
F_s = F_s+a(i).*cos(i*pi*t/l)+b(i).*sin(i*pi*t/l); % a(i).*cos(i*pi*t/l)+b(i).*sin(i*pi*t/l) is called fundamentals of harmonics or
subplot(n1,1,i)
ezplot(F_s, [x(1) x(n)])
end
disp('Fourier series :')
vpa(F_s,4)
```

Que1)

The turning moment T on the crankshaft of a steam engine for the crank angle θ degrees is given as follows :

θ :	0	15	30	45	60	75	90	105	120	135	150	165	180
T :	0	2.7	5.2	7.0	8.1	8.3	7.9	6.8	5.5	4.1	2.6	1.2	0

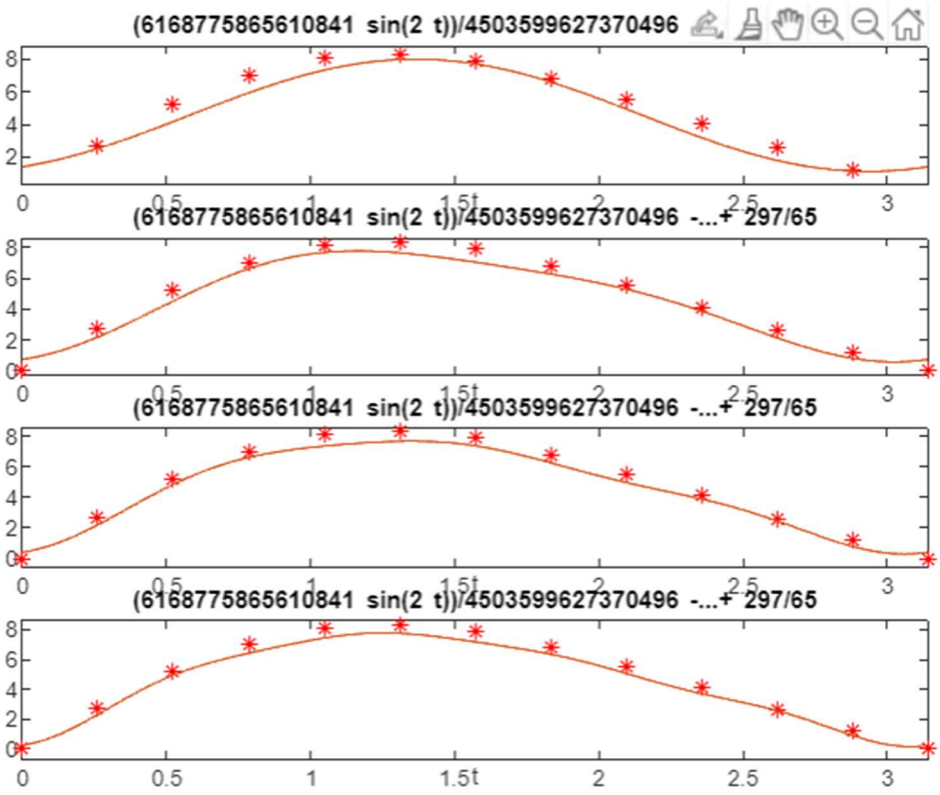
Expand T in a series of sines upto the fourth harmonics.

Command Window-

Command Window

```
Enter the y values (as a row vector) :
[0 2.7 5.2 7.0 8.1 8.3 7.9 6.8 5.5 4.1 2.6 1.2 0]

y =

  Columns 1 through 7

         0    2.7000    5.2000    7.0000    8.1000    8.3000    7.9000

  Columns 8 through 13

    6.8000    5.5000    4.1000    2.6000    1.2000         0


a_0 =

    9.1385

Fourier series :

ans =

1.37*sin(2.0*t) - 0.6769*cos(4.0*t) - 0.1846*cos(8.0*t) - 3.154*cos(2.0*t) + 5.807e-16*sin(4.0*t) + 1.366e-16*sin(8.0*t) - 0.3231*cos(6.0*t) +
0.01538*sin(6.0*t) + 4.569
```

PLOT-


(6168775865610841 sin(2 t))/4503599627370496
(6168775865610841 sin(2 t))/4503599627370496 -...+ 297/65
(6168775865610841 sin(2 t))/4503599627370496 -...+ 297/65
(6168775865610841 sin(2 t))/4503599627370496 -...+ 297/65
0
0.5
1
1.5t
2
2.5
3
2
4
6
8

Que2)

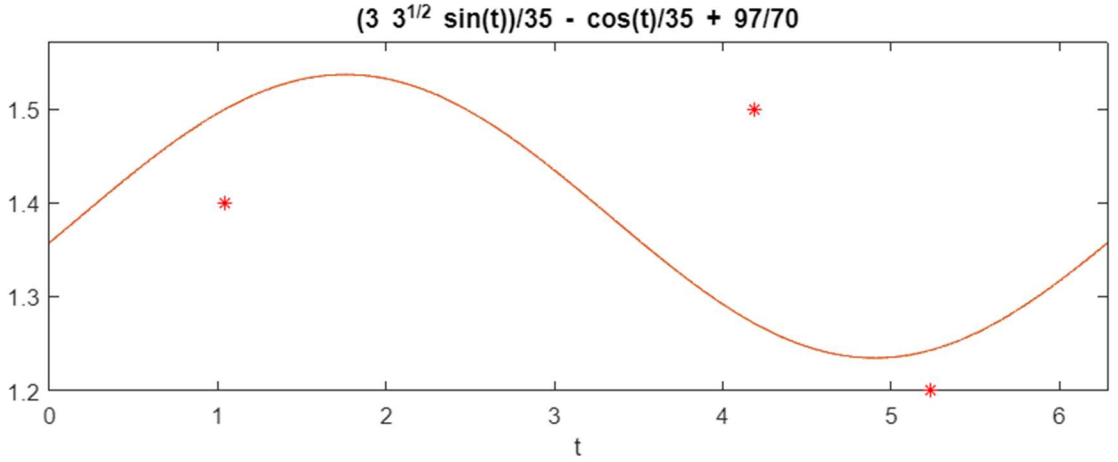
Compute the first two harmonics of the Fourier series of $f(x)$ given in the following table :

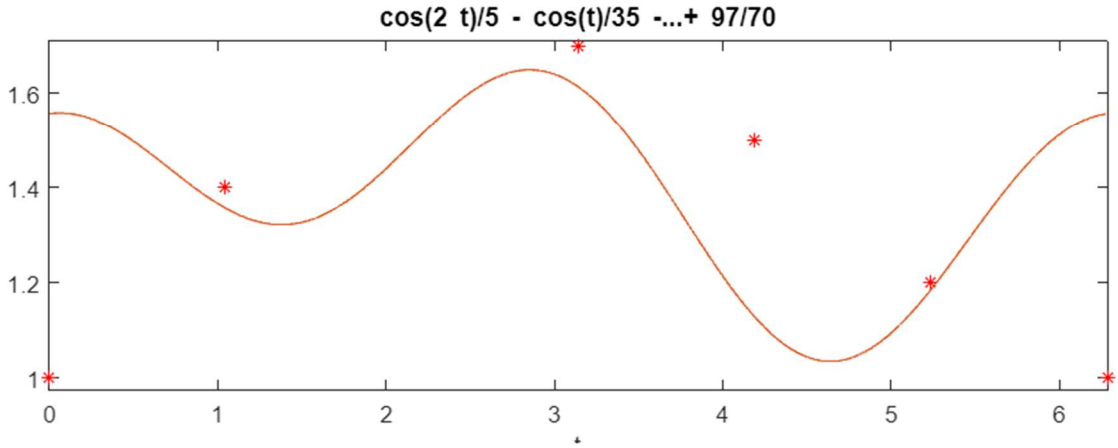
2. x :	0	$\pi/3$	$2\pi/3$	π	$4\pi/3$	$5\pi/3$	2π
$f(x)$:	1.0	1.4	1.9	1.7	1.5	1.2	1.0

Command Window-

```
Command Window
0
type 0 if the unit of x is deg. type a non-zero number otherwise
0
Enter the length of the spacing between successive values of x :
60
Enter the number of harmonic of the series n1 :
2
Enter the y values (as a row vector) :
[1.0 1.4 1.9 1.7 1.5 1.2 1.0]


y =

    1.0000    1.4000    1.9000    1.7000    1.5000    1.2000    1.0000


a_0 =

    2.7714

Fourier series :

ans =

0.2*cos(2.0*t) - 0.04949*sin(2.0*t) - 0.02857*cos(t) + 0.1485*sin(t) + 1.386
```

Output-


(3 3^1/2 sin(t))/35 - cos(t)/35 + 97/70
1.5
1.4
1.3
1.2
0
1
2
3
4
5
6
t


cos(2 t)/5 - cos(t)/35 -...+ 97/70
1.6
1.4
1.2
1
0
1
2
3
4
5
6