EE2703 : Applied Programming Lab
Assignment 4

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EP17B002

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Abstract

This assignment is about finding the Fourier coefficients of the two given functions i.e. exp(x) and cos(cos(x)) and reconstructing them from their Fourier series.

Introduction

The Fourier series of a function f(x) is given by the following formula :

$$x(t) = a_0 + \sum_{n=1}^{\infty} a_n cos\left(\frac{2\pi n}{T}t\right) + b_n \sin\left(\frac{2\pi n}{T}t\right)$$

where a_n and b_n are the Fourier coefficients of the function and can be found using the following formulae:

$$a_0 = \frac{1}{T}\int_0^T x(t)dt$$

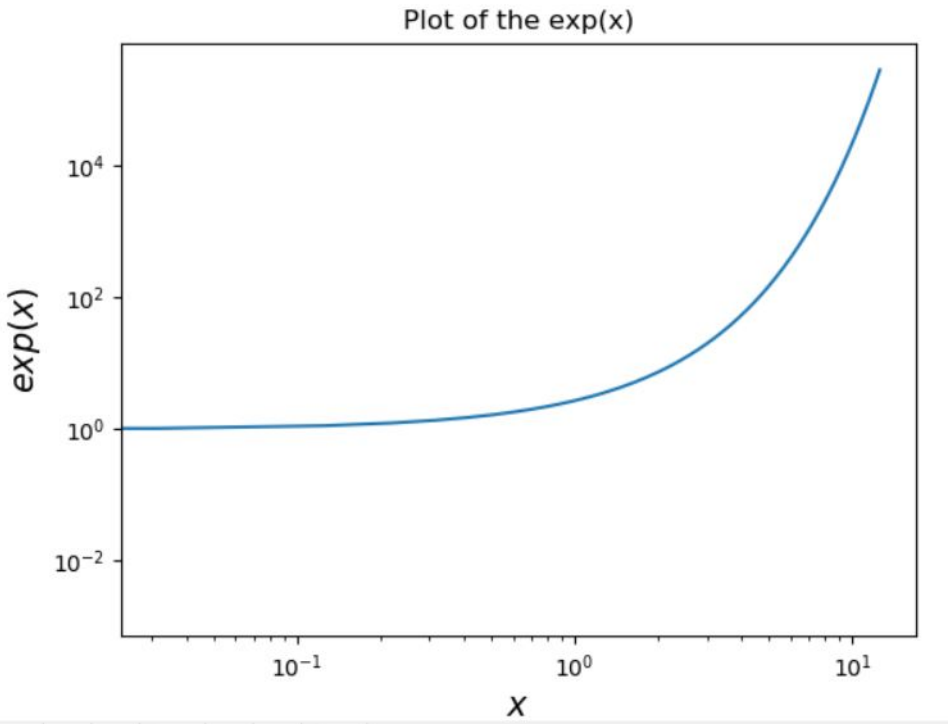
$$a_n = \frac{2}{T}\int_0^T x(t)\cos\left(\frac{2\pi n}{T}t\right)dt$$

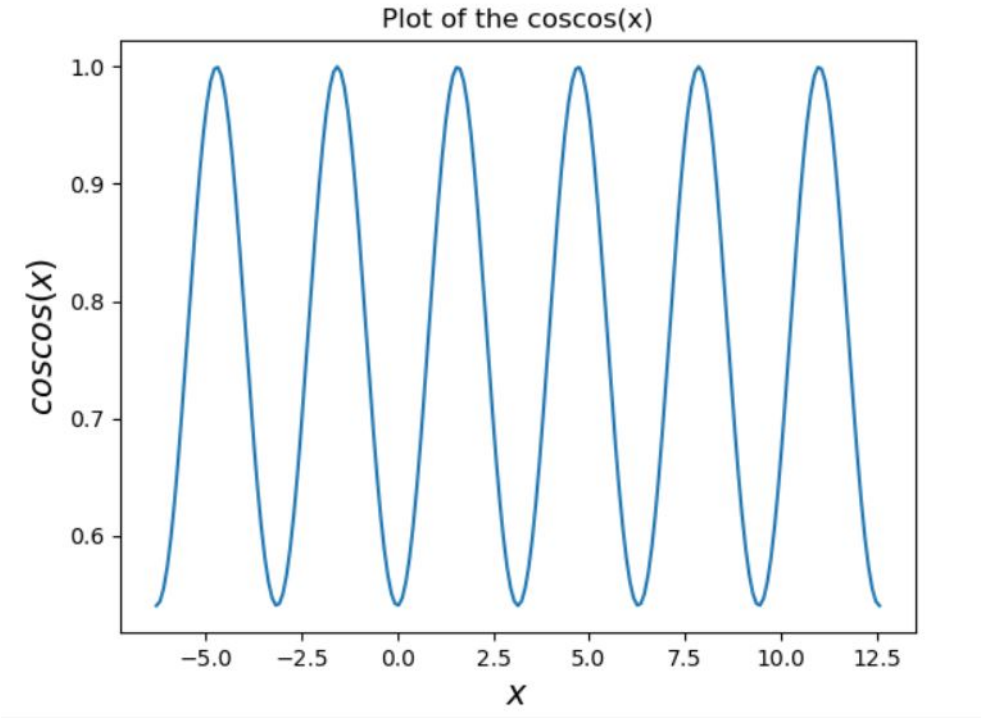
$$b_n = \frac{2}{T}\int_0^T x(t)\sin\left(\frac{2\pi n}{T}t\right)dt$$

Problems with solutions and outputs

0.0.1 Problem 1

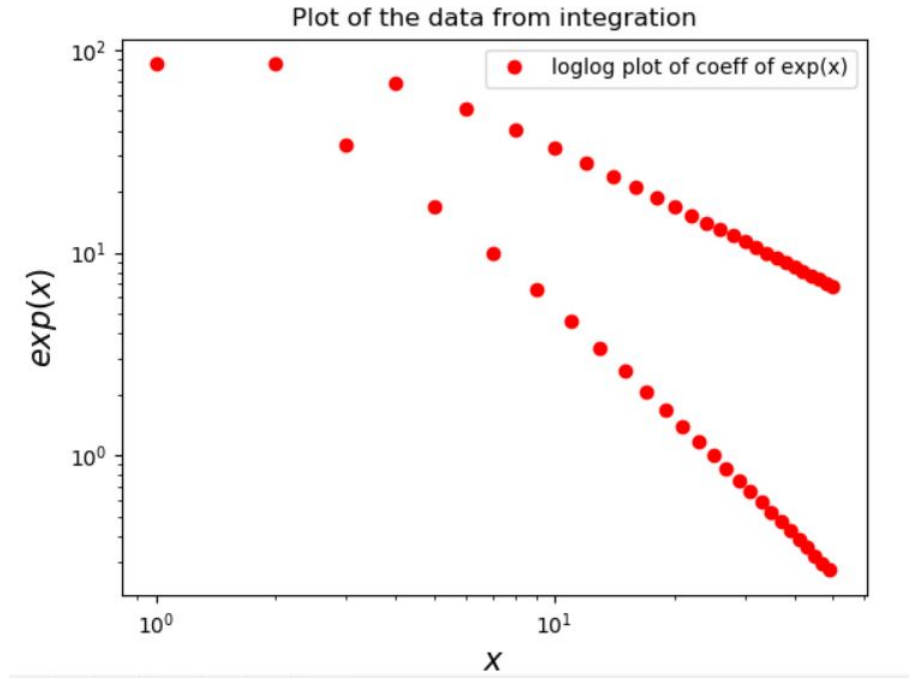
Plotting exp(x) and cos(cos(x))

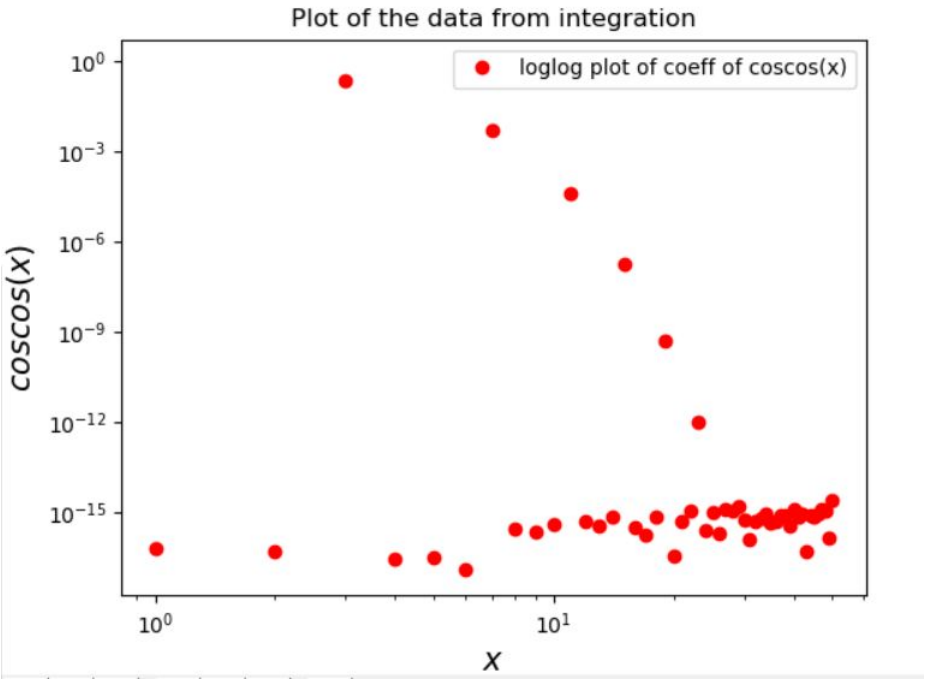

Plot of the exp(x)
10^4
10^2
10^0
10^{-2}
exp(x)
10^{-1}
10^0
10^1
x

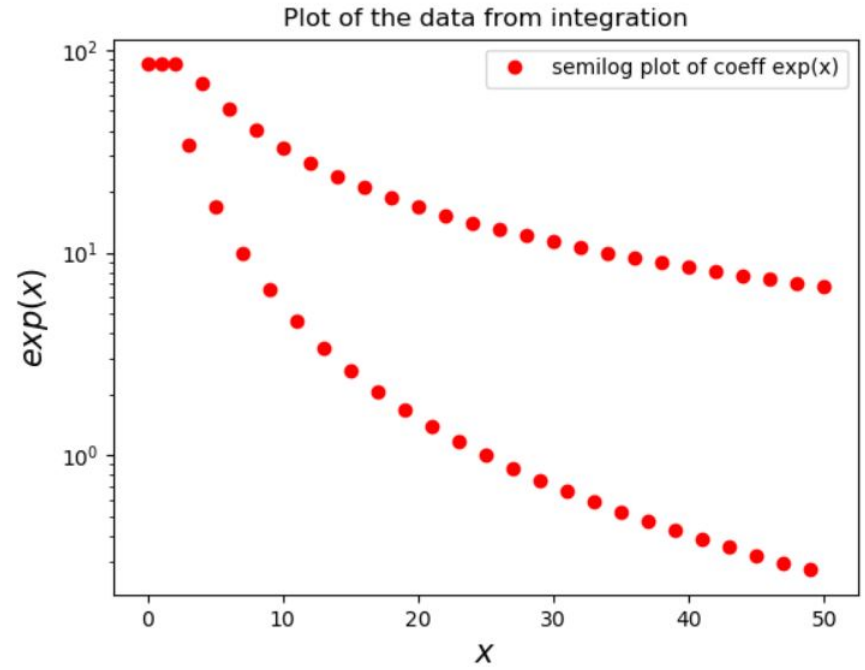

Plot of the coscos(x)
1.0
0.9
0.8
0.7
0.6
coscos(x)
−5.0
−2.5
0.0
2.5
5.0
7.5
10.0
12.5
x

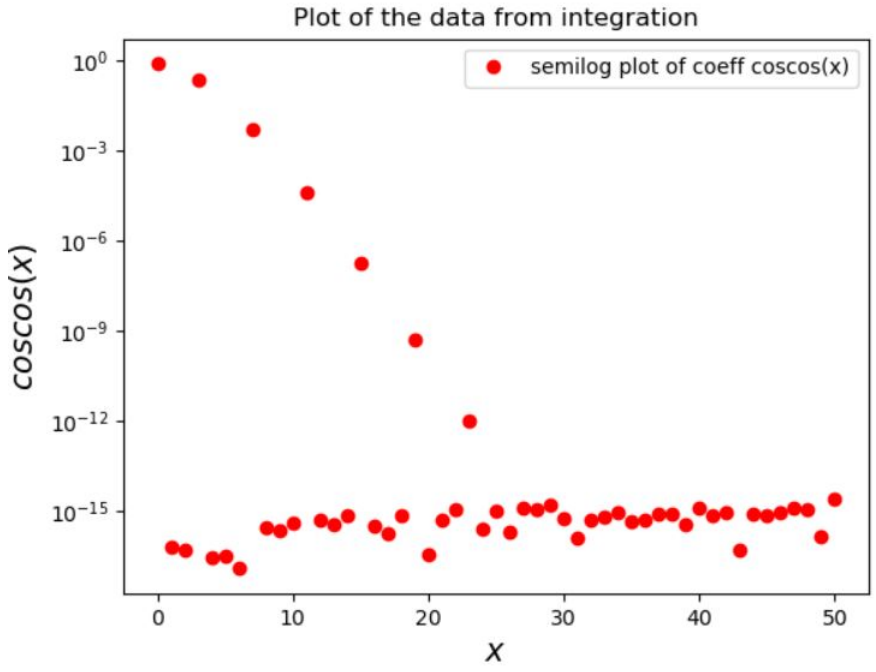
0.0.2 Problem 2

Plotting the coefficients for f1(x) = exp(x) and the coefficients for cos(cos(x)).



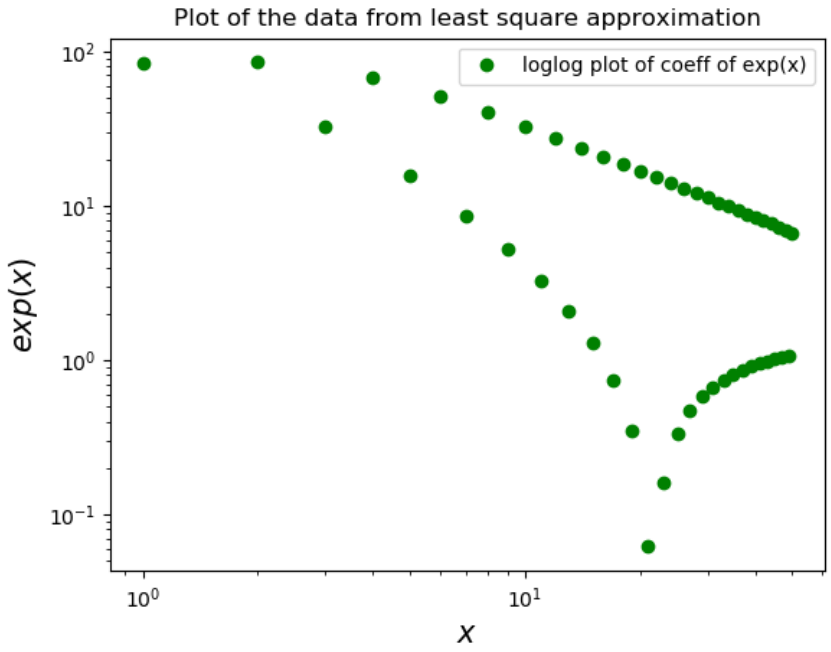


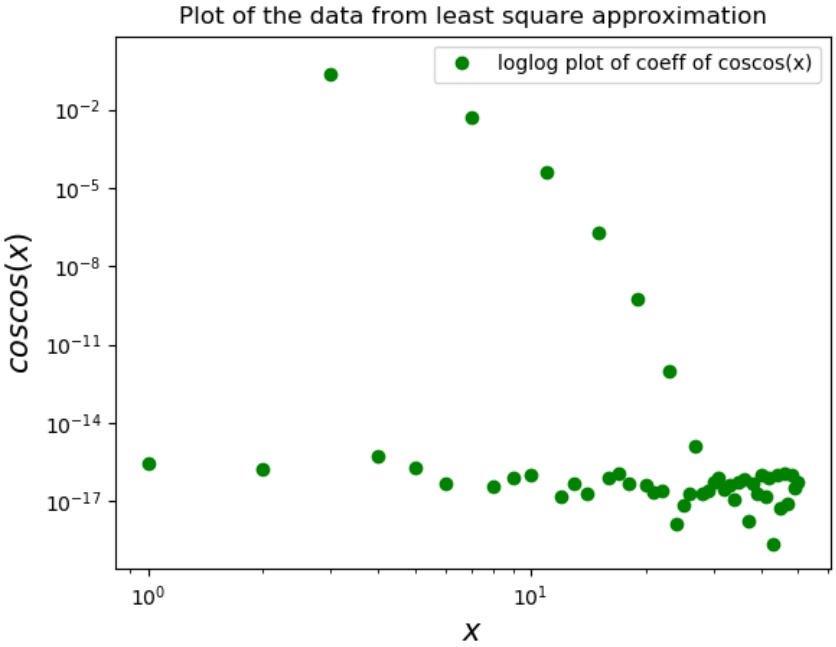

Plot of the data from integration
semilog plot of coeff exp(x)
10^2
10^1
10^0
exp(x)
0
10
20
30
40
50
x

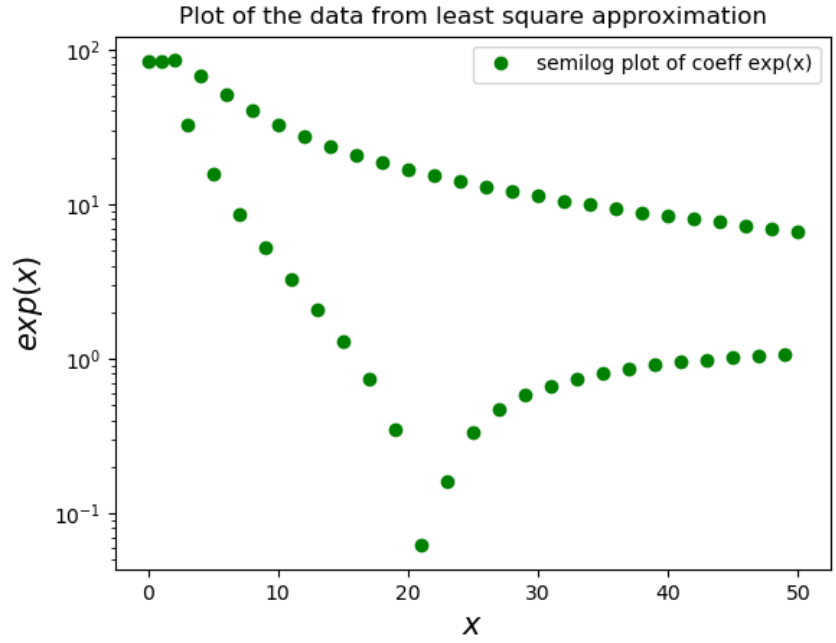

Plot of the data from integration
semilog plot of coeff coscos(x)
10^0
10^{-3}
10^{-6}
10^{-9}
10^{-12}
10^{-15}
coscos(x)
0
10
20
30
40
50
x

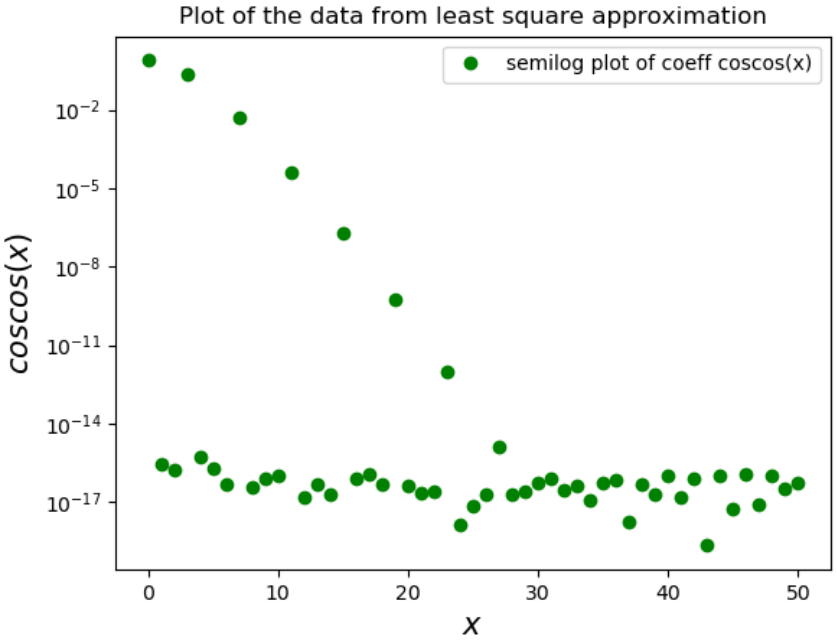
0.0.3 Problem 3

"Least Squares approach" to the problem. Finding the Fourier coefficients of the functions by solving and finding the least square solution of the matrix equation Ax = b.






Plot of the data from least square approximation
semilog plot of coeff exp(x)
10^2
10^1
10^0
10^{-1}
exp(x)
0
10
20
30
40
50
x

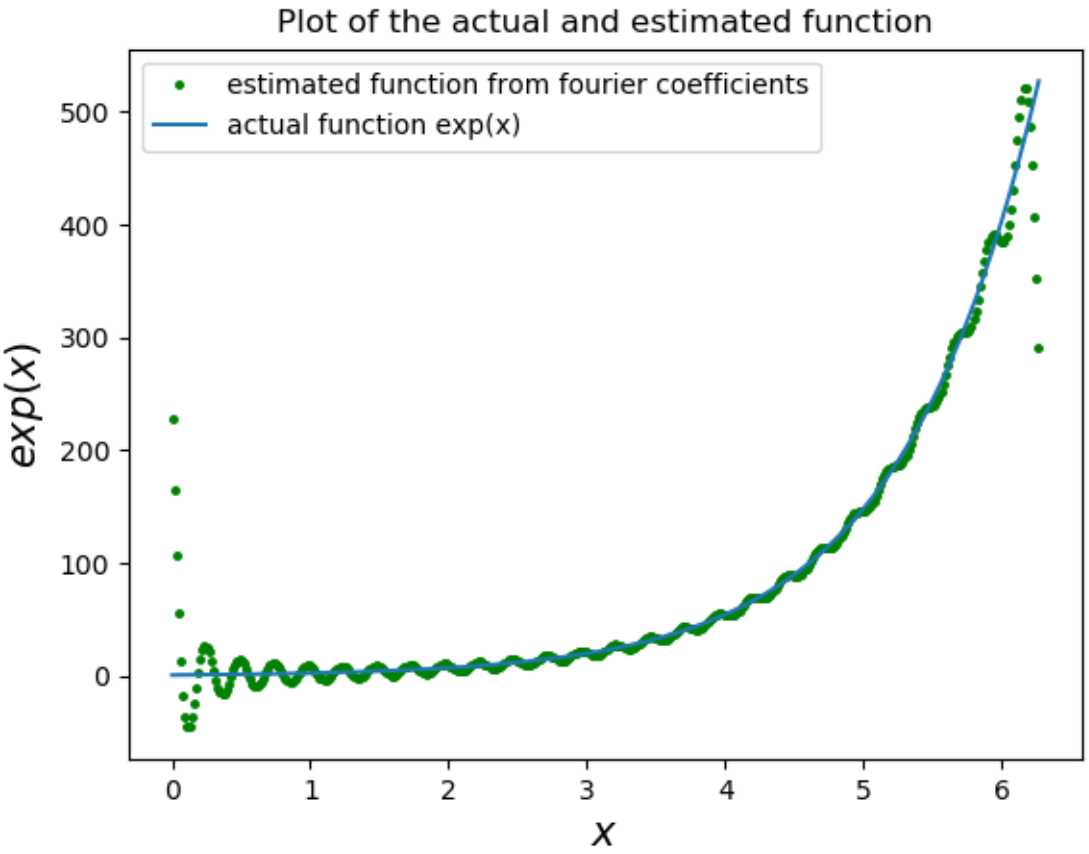

Plot of the data from least square approximation
semilog plot of coeff coscos(x)
10^{-2}
10^{-5}
10^{-8}
10^{-11}
10^{-14}
10^{-17}
coscos(x)
0
10
20
30
40
50
x

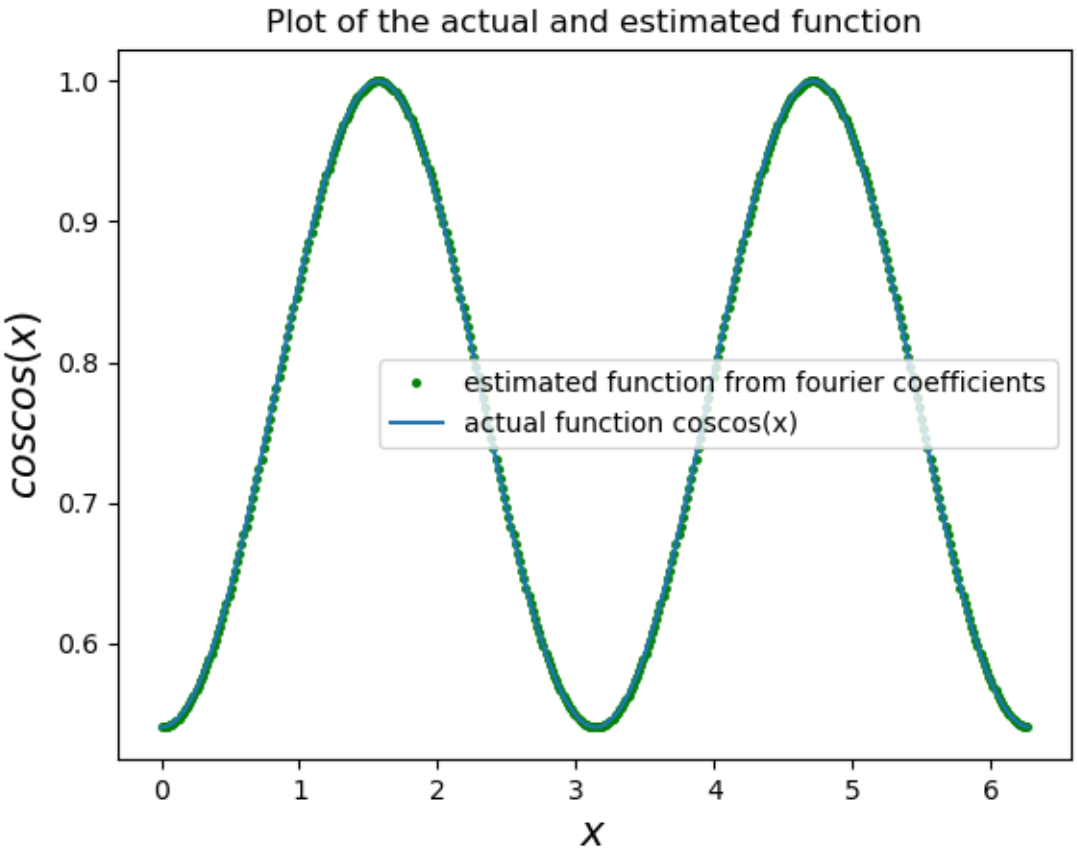
0.0.4 Problem 4

Finding the absolute difference between the two sets of coefficients and finding the largest deviation.
Largest deviation in An coefficients = 1.332730870335368
Largest deviation in Bn coefficients = 2.5394379427569514e-15

0.0.5 Problem 5

Plotting the actual functions and the estimated functions from the Fourier coefficients obtained from least square method




Plot of the actual and estimated function
1.0
0.9
0.8
0.7
0.6
coscos(x)
0
1
2
3
4
5
6
x
estimated function from fourier coefficients
actual function coscos(x)