A collaborative LaTeX document

Class of ID2090, Third Trimester of 2021 batch

June 14, 2022

Contents

List of Figures

List of Tables

1 Introduction

This file includes tex files from the folders of each student. The students are expected to update the file named after their roll number and place any images in the same folder. Students do not have to edit this master document. Once the student has sent a pull request which is accepted and processed successfully, his/her assignment submission is deemed to be complete.

You are also welcome to add references and cite them. Examples on how to do that are on the course repository [?].

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Assignment 4 Sameer Surla CE21B112 June 2022

14.1 Taylor's Series

The Taylor series of a real or complex-valued function f(x) that is infinitely differentiable at a real or complex number a is the power series

$$f(a) + f'(a)\frac{(x-a)}{1!} + f''(a)\frac{(x-a)^2}{2!} + f'''(a)\frac{(x-a)^3}{3!} + ... \tag{1}$$

where n! denotes the factorial of n. In the more compact sigma notation, this can be written as

$$\sum_{n=0}^{\infty} \frac{f^{(n)}(x)}{n!}(x-a)^n \tag{2}$$

where $f^{(n)}(a)$ denotes the nth derivative of f evaluated at the point a. (The derivative of order zero of f is defined to be f itself and $(x-a)^0$ and 0! are both defined to be 1.)

When a = 0, the series is also called a Maclaurin series. The Taylor series of any polynomial is the polynomial itself.
The Maclaurin series of $\frac{1}{1-x}$ is the geometric series

$$1 + x + x^2 + x^3 + x^4 + ... \tag{3}$$

14.1.1 Exponential function

The exponential function e^x (with base e) has Maclaurin series

$$ln(1-x) = -\sum_{n=1}^{\infty} \frac{x^n}{n!} = 1 + x + \frac{x^2}{2!} + \frac{x^3}{3!} + ... \tag{4}$$

It converges for all x.

14.1.2 Natural logarithm

The natural logarithm (with base e) has Maclaurin series

$$ln(1-x) = -\sum_{n=1}^{\infty} \frac{x^n}{n!} = -x - \frac{x^2}{2!} - \frac{x^3}{3!} - ... \tag{5}$$

$$ln(1+x) = \sum_{n=1}^{\infty} (-1)^{n-1}\frac{x^n}{n!} = \frac{x^2}{2!} + \frac{x^3}{3!} - ... \tag{6}$$

They converge for $|x| < 1$. (In addition, the series for $ln(1-x)$ converges for x=-1, and the series for $ln(1+x)$ converges for x = 1.)

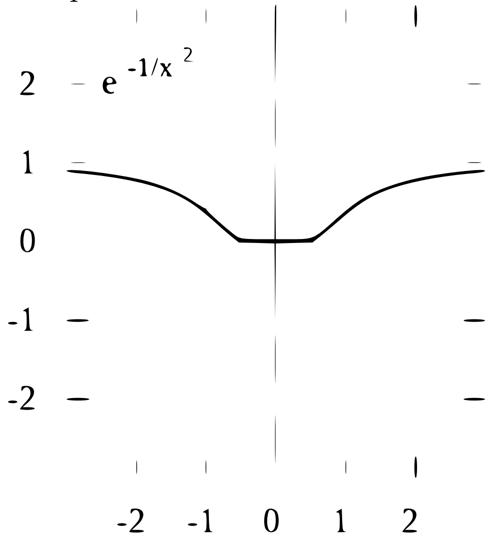
If f(x) is given by a convergent power series in an open disk centred at b in the complex plane (or an interval in the real line), it is said to be analytic in this region. Thus for x in this region, f is given by a convergent power series

$$f(x) = \sum_{n=0}^{\infty} a_n (x-b)^n.$$

Differentiating by x the above formula n times, then setting x = b gives:

$$\frac{f^{(n)}(b)}{n!} = a_n$$

and so the power series expansion agrees with the Taylor series. Thus a function is analytic in an open disk centred at b if and only if its Taylor series converges to the value of the function at each point of the disk.



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44 Conclusions

If this master tex file could be compiled successfully, it means that the class has learnt the concepts of Git as well as LaTeX properly.

45 References

References

[1] Repository for id2090 course. `https://github.com/gphanikumar/mm2090`. Accessed: 2022-06-13.