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Kompl Eyler's Formula In Hex Analysis And Some Results In Elementary And Higher Mathematics

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ABSTRACT

This article is devoted to solving some of the problems of elementary mathematics with the help of a conformal invariant, which has its own advantages, applied in the theory of modern functions, as well as some important issues of mathematical analysis with the help of Komplex numbers, several results obtained with the help of the Eyler formula and their application in practice.

KEYWORDS

z_n, $z_n = \lim_{n\to\infty}\left(1+\frac{z}{n}\right)^n$, Eyler formula, aggregate, integral, $\sin x = \frac{1}{2i}(e^{ix} - e^{-ix})$, $\cos x = \frac{1}{2}(e^{ix} + e^{-ix})$

INTRODUCTION

1. Eyler formula

2. Kompl let's look at the following sequence by taking an optional z number in the plane of hexadecimal numbers

3.

$$z_n = \left(1 + \frac{z}{n}\right)^n$$

4.It is known that Komplex sequence of numbers $n \to \infty$ has a limit.

5.From the course of mathematical analysis we know that this $z_n = \lim_{n\to\infty}\left(1 + \frac{z}{n}\right)^n$

6.sequence limit e^z the function is called.

$z \in C$ Komplex number this $z = r(\cos\varphi + i\sin\varphi)$ given in appearance n. Komplex is one of the following important formulas known from the course of analysis

$$e^{i\varphi} = \cos\varphi + i\sin\varphi$$

With the help of the Eyler formula Komplex number we can write the following

$$z = re^{i\varphi} \qquad (1)$$

We know that given two $z_1 = x_1 + iy_1$ va $z_2 = x_2 + iy_2$ Komplex numbers to be equal $x_1 = x_2$ va $y_1 = y_2$ be necessary and sufficient

Let's go through the solutions of the results obtained using the Eyler formula and a few examples that are important.

7. **Results obtained using Eyler formula**

1-example. Calculate the given sum

a) $1 + \cos x + \cos 2x + ... + \cos nx$

b) $\sin x + \sin 2x + ... + \sin nx$

$S_1 = 1 + \cos x + \cos 2x + ... + \cos nx$ and $S_2 = \sin x + \sin 2x + ... + \sin nx$ let it be. Let's look at the sum as follows

$$S_1 + iS_2 = 1 + \cos x + i\sin x + \cos 2x + i\sin 2x + ... + \cos nx + i\sin nx$$

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According to Eyler's formula, we can write this sum as follows

$$S_1 + iS_2 = 1 + e^{ix} + e^{i2x} + \ldots + e^{inx} = \frac{e^{i(n+1)x} - 1}{e^{ix} - 1} = \frac{\cos(n+1)x + i\sin(n+1)x - 1}{(\cos x - 1) + i\sin x} =$$

$$= \frac{(\cos(n+1)x + i\sin(n+1)x - 1)((\cos x - 1) - i\sin x)}{(\cos x - 1)^2 + \sin^2 x}$$

As a result of simplification of the formed expression, we get the following

$$S_1 + iS_2 = \frac{\cos(nx) - \cos((n+1)x) - \cos(x) + 1}{2 - 2\cos x} +$$

$$+ i\frac{\sin(nx) - \sin((n+1)x) + \sin(x)}{2 - 2\cos x}$$

Komplex according to the theorem on the equality of numbers

$$S_1 = \frac{\cos(nx) - \cos((n+1)x) - \cos(x) + 1}{2 - 2\cos x}$$

$$S_2 = \frac{\sin(nx) - \sin((n+1)x) + \sin(x)}{2 - 2\cos x}$$

2-example. Calculate the sum given below

$$S_n = \cos x + 2\cos 2x + 3\cos 3x + \ldots + n\cos nx$$

Solution Initially, we calculate the following sum

$$T_n = \sin x + \sin 2x + \sin 3x + \ldots + \sin nx$$

Through the above examples, it is known that the sum is equal to

$$T_n = \frac{\sin nx - \sin(n+1)x + \sin x}{2 - 2\cos x}$$

From what is known, the first orderly harvest will be equal to. All in all

$$S_n = \left(\frac{\sin nx - \sin(n+1)x + \sin x}{2 - 2\cos x} \right)' = \left(\frac{\sin\left(\frac{nx}{2}\right)\sin\left(\frac{n+1}{2}x\right)}{\sin\left(\frac{x}{2}\right)} \right)' =$$

$$= \frac{n \sin\frac{x}{2}\sin\left(\frac{2n+1}{2}x\right) - \sin^2\frac{nx}{2}}{2\sin^2\frac{x}{2}}$$

3- example. Calculate:

$$I_1 = \int e^{ax}\cos(bx)dx$$

$$I_2 = \int e^{ax}\sin(bx)dx$$

Solution: we write the above two integers as follows

$$I_1 + iI_2 = \int e^{ax}\cos(bx)dx + i\int e^{ax}\sin(bx)dx \qquad (1)$$

We look at the integral below.

$$\int e^{ax}e^{ibx}dx = \int e^{(a+ib)x}dx = \frac{e^{(a+ib)x}}{a+ib} + C = \frac{a-ib}{a^2+b^2}e^{(a+ib)x} + C =$$

$$= \frac{a-ib}{a^2+b^2}e^{ax}e^{ibx} + C$$

Now according to Eyler's formula $e^{ibx} = \cos bx + i\sin bx$ we can write the above example as follows

$$\frac{(a-ib)(\cos bx + i\sin bx)}{a^2+b^2}e^{ax} = \frac{a\cos bx + b\sin bx}{a^2+b^2}e^{ax} + i\frac{a\sin bx - b\cos bx}{a^2+b^2}e^{ax}$$

(2)

As a result of the equation of (1) and (2) expressions according to the above theorem, we get the following

$$\int e^{ax}\cos(bx)dx = \frac{a\cos bx + b\sin bx}{a^2+b^2}e^{ax} + C$$

$$\int e^{ax}\sin(bx)dx = \frac{a\sin bx - b\cos bx}{a^2+b^2}e^{ax} + C$$

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4-example. Calculate:

$$\int_0^{\pi} \frac{\sin nx}{\sin x} dx$$

Solution: according to the known Eyler formula $\sin x = \frac{1}{2i}(e^{ix} - e^{-ix})$ and

$\sin nx = \frac{1}{2i}(e^{inx} - e^{-inx})$ all in all

$$\frac{\sin nx}{\sin x} = \frac{e^{inx} - e^{-inx}}{e^{ix} - e^{-ix}} = \sum_{k=1}^{n} e^{i(n+1-2k)x} = e^{i(n-1)x} + e^{i(n-3)x} + \ldots + e^{-i(n-3)x} + e^{-i(n-1)x} \quad (1)$$

$\cos x = \frac{1}{2}(e^{ix} + e^{-ix})$ given that (1) we can write the expression as follows

$$e^{i(n-1)x} + e^{i(n-3)x} + \ldots + e^{-i(n-3)x} + e^{-i(n-1)x} =$$
$$= \begin{cases} 2(\cos(n-1)x + \cos(n-3)x + \ldots + \cos x), n - juft \\ 2(\cos(n-1)x + \cos(n-3)x + \ldots \cos x) + 1, n - toq \end{cases} \quad (2)$$

Now we look at the following integral

$$\int_0^{\pi} \cos(n-k)x dx = \frac{\sin(n-k)x}{n-k} \Big|_0^{\pi} = 0 \quad (3)$$

Hence (3) according to the expression

$$\int_0^{\pi} \frac{\sin nx}{\sin x} dx = \begin{cases} 0, n - juft \\ \pi, n - toq \end{cases}$$

5-example. Calculate:

$$I = \int_0^{\pi} \frac{\cos((2n+1)x)}{\cos x} dx$$

Solution: according to Eyler formula $\cos x = \frac{1}{2}(e^{ix} + e^{-ix})$ furthermore

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$$\frac{\cos((2n+1)x)}{\cos x}=\frac{e^{i(2n+1)x}+e^{-i(2n+1)x}}{e^{ix}+e^{-ix}}=e^{i2nx}-e^{i(2n-2)x}+...+e^{-i2nx}=$$

$$=2\sum_{k=1}^{n}(-1)^{k-1}\cos(2(n-(k-1))x)+(-1)^n$$

(1) through the expression, we can write the above given integral as follows

$$I=2\sum_{k=1}^{n}\int_0^{\pi}\cos(2(n-(k-1))x)dx+(-1)^n\pi=2\sum_{k=1}^{n}\frac{\sin(2(n-(k-1))x)}{2(n-(k-1))}\Big|_0^{\pi}+(-1)^n\pi=$$
$$=(-1)^n\pi$$

6- example. Calculate:

$$\begin{aligned}S_1&=q\sin x+q^2\sin 2x+q^3\sin 3x+...+q^n\sin nx+...\\ S_2&=q\cos x+q^2\cos 2x+q^3\cos 3x+...+q^n\cos nx+...\end{aligned}\qquad |q|<1$$

Solution. Let's look at the sum below

$$S_1+iS_2=q(\cos x+i\sin x)+q^2(\cos 2x+i\sin 2x)+...+q^n(\cos nx+i\sin nx)+...$$

According to Eyler's formula

$$S_1+iS_2=qe^{ix}+q^2e^{ix}+...+q^ne^{inx}+...=\frac{qe^{ix}}{1-qe^{ix}}=\frac{q(\cos x+i\sin x)}{1-q\cos x-iq\sin x}$$

As a result of simplifying this generated sum, we will have the following

$$S_1+iS_2=\frac{q\cos x-q^2}{1-2q\cos x+q^2}+i\frac{q\sin x}{1-2q\cos x+q^2}$$

According to the theorem about the equality of commas numbers

$$S_1=\frac{q\cos x-q^2}{1-2q\cos x+q^2}$$

$$S_2=\frac{q\sin x}{1-2q\cos x+q^2}$$

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