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# METHODS FOR CALCULATING SOME IMPORTANT INTEGRALS USING PARAMETER-DEPENDENT INTEGRALS

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**Abstract:**

This paper examines some of the inherent integrals that are important in many fields: Dirichlet integrals, Euler-Poisson integrals, Laplace integrals, Fresnelli integrals, and how to calculate their values. The properties of the parameter-dependent integrals were used to calculate their values.

**Keywords:** Dirichlet integrals, Euler-Poisson integrals, Laplace integrals, Fresnelli integrals

1. Dirixle integral.

$J=\int_0^\infty \frac{\sin x}{x}dx$ There are many ways to calculate the Dirichlet integral. We calculate the value of this Dirixle integral using parameter-dependent integrals. for this

$$J_\alpha=\int_0^\infty \frac{\sin \alpha x}{x}dx,\ (\alpha>0)$$

we look at the integral.
This is intagral $\alpha$ differentiate according to the parameter. However, $\alpha$ differentiate by

$$\frac{dJ_\alpha}{d\alpha}=\int_0^\infty \cos\alpha x\,dx$$

integral according to Leibniz's rule. For this reason, $e^{-kx},\ k>0$ We introduce the concept of "convergent multiplier". That's why

$$J_k(\alpha)=\int_0^\infty e^{-kx}\frac{\sin\alpha x}{x}dx,\ (\alpha\geq 0,\ k>0)$$

function

$J_k(\alpha)$ from the function $\alpha$ Taking the specific product of, we find:

$$\frac{\partial J_k(\alpha)}{\partial\alpha}=\int_0^\infty e^{-kx}\cos\alpha x\,dx=I\,.$$

The function under the integral in the above integral $\alpha\in[0,\infty)$ is always present and integral convergent. By integrating it into two parts

$$I=\frac{k}{\alpha^2+k^2}$$

we find that
And so,

$$\frac{\partial J_k(\alpha)}{\partial\alpha}=\frac{k}{\alpha^2+k^2}.$$

From this,

$$J_k(\alpha)=arctg\frac{\alpha}{k}+C$$

occurs.

$J_k(0)=0$ attitude $C=0$ and $J_k(\alpha)=arctg\frac{\alpha}{k}$ It turns out that

$\alpha=const$ if so $J_k(\alpha)$ expression $k$ remains a function of. $k\to+0$ If we go to the limit in, then

$$J_\alpha=\lim_{k\to+0}J_k(\alpha)=\lim_{k\to+0}\left(arctg\frac{\alpha}{k}\right)=\frac{\pi}{2}$$

we have equality.

In particular, $\alpha=1$ when

$$J_1=J=\int_0^\infty\frac{\sin x}{x}dx=\frac{\pi}{2}$$

It turns out that

2. Euler-Poisson integral.

This is in this paragraph $J=\int_0^\infty e^{-x^2}dx$ - We calculate the value of the Euler-Poisson integral. To do this, first $x=nt$ We will do the replacement here $n$ arbitrary positive number. In that case

$$J=n\cdot\int_0^\infty e^{-n^2t^2}dt$$

is equally appropriate. To both sides of the equation $e^{-n^2}$ multiplying the expression, and then $0$ and $\infty$ until $n$ Integrating on the following

$$J\cdot\int_0^\infty e^{-n^2}dn=\int_0^\infty e^{-n^2}n\,dn\int_0^\infty e^{-n^2t^2}dt$$

or

$$J=\int_0^\infty ne^{-n^2}dn\int_0^\infty e^{n^2t^2}dt$$

we create an equation. In the calculation of the last integral, by substituting the variables, we get:

$$J^2=\int_0^\infty dt\left(\int_0^\infty e^{-(1+t^2)n^2}ndn\right)=\int_0^\infty dt\left(\frac{1}{2}\int_0^\infty e^{-(1+t^2)n^2}d(1+n^2)\right)=\frac{1}{2}\int_0^\infty dt\left(-\frac{1}{1+t^2}e^{-(1+t^2)n}\Big|_0^\infty\right)=$$

$$=\frac{1}{2}\int_0^\infty\frac{1}{1+t^2}dt=\frac{1}{2}arctgt\Big|_0^\infty=\frac{\pi}{4}$$

From this

$$J=\frac{\sqrt{\pi}}{2}$$

equality is appropriate.

3. Laplace integrals.

This

$$L_1=\int_0^\infty\frac{\cos\beta x}{\alpha^2+x^2}dx \text{ and } L_2=\int_0^\infty\frac{x\sin\beta x}{\alpha^2+x^2}dx,\quad(\alpha,\ \beta>0)$$

integrals are called Laplace integrals.

This

$$\int_0^\infty e^{-t\cdot\left(\alpha^2+x^2\right)}dt=\frac{1}{\alpha^2+x^2}$$

using the equation

$$L_1=\int_0^\infty\cos\beta xdx\int_0^\infty e^{-t\cdot\left(\alpha^2+x^2\right)}dt$$

we create an equation. By changing the order of integration, the following

$$L_1 = \int_0^\infty e^{-\alpha^2 t}\, dt \left( \int_0^\infty e^{-tx^2} \cos \beta x \, dx \right) = \int_0^\infty J(t) \cdot e^{-\alpha^2 t}\, dt$$

we create an equation. Here

$$J(t) = \int_0^\infty e^{-tx^2} \cos \beta x \, dx$$

According to the method of calculating the integral [2],

$$J(t) = \frac{1}{2}\sqrt{\frac{\pi}{t}} \cdot e^{-\frac{\beta^2}{4t}}$$

we find the relationship. In that case, according to [2],

$$L_1 = \frac{\sqrt{\pi}}{2} \int_0^\infty e^{-\alpha^2 t - \frac{\beta^2}{4t}} \cdot \frac{dt}{\sqrt{t}}$$

occurs.

$t = z^2$ If we enter the switch,

$$L_1 = \sqrt{\pi} \cdot \int_0^\infty e^{-\alpha^2 z^2 - \frac{\beta^2}{4z^2}} dz = e^{-2\alpha\beta} \int_0^\infty e^{-\left(\alpha z - \frac{\beta}{z}\right)^2} dz = \frac{\sqrt{\pi}}{\alpha} e^{-\alpha\beta} \cdot \int_0^\infty e^{-y^2} dy = \frac{\pi}{2\alpha} \cdot e^{-\alpha\beta}$$

we form a relationship.

And so,

$$L_1 = \frac{\pi}{2\alpha} \cdot e^{-\alpha\beta}$$

equality would be appropriate.

$$L_2 = -\frac{dL_1}{d\beta}$$

considering the relationship, $L_2$ for we have the following equation:

$$L_2 = \frac{\pi}{2} e^{-\alpha\beta} \ .$$

4. Fresnel integrals.

This

$$F_1 = \int_0^\infty \sin x^2 dx \ \text{ and } \ F_2 = \int_0^\infty \cos x^2 dx$$

integrals are called Fresnel integrals. The following

$$\left|\sin x^2\right| \le 1, \quad \left|\cos x^2\right| \le 1$$

because the inequalities are reasonable $F_1$ and $F_2$ integrals are convergent integrals. To calculate their value $x^2 = t$ make the switch. It was formed

$$F_1 = \int_0^\infty \sin x^2 dx = \frac{1}{2}\int_0^\infty \frac{\sin t}{\sqrt{t}} dt \ \text{ and } \ F_2 = \int_0^\infty \cos x^2 dx = \frac{1}{2}\int_0^\infty \frac{\cos t}{\sqrt{t}} dt$$

under the integrals $\frac{1}{\sqrt{t}}$ We replace the expression with the following integral:

$$\frac{1}{\sqrt{t}} = \frac{2}{\sqrt{\pi}} \int_0^\infty e^{-tn^2} dn \ .$$

The result is the following equation:

$$\int_0^\infty \frac{\sin t}{\sqrt{t}} dt = \frac{2}{\sqrt{\pi}} \int_0^\infty \sin t \, dt \int_0^\infty e^{-tn^2} dn \ .$$

In the last integral we replace the variables of the integrals:

$$F_1 = \int_0^\infty \frac{\sin t}{\sqrt{t}}\,dt = \frac{2}{\sqrt{\pi}}\int_0^\infty \sin t\,dt \int_0^\infty e^{-tn^2}\,dn = \frac{2}{\sqrt{\pi}}\int_0^\infty dn\left(\int_0^\infty e^{-tn^2}\sin t\,dt\right) = \frac{2}{\sqrt{\pi}}\int_0^\infty \frac{dn}{1+n^2} = \frac{2}{\sqrt{\pi}}\cdot\frac{\pi}{2\sqrt{2}} = \sqrt{\frac{\pi}{2}}$$

we create an equation.

Similarly, we construct this equation $F_2 = \sqrt{\frac{\pi}{2}}$ .

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