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# DISC INTEGRATION METHOD TO DETERMINE THE VOLUME OF A ROTARY OBJECT TWO DIMENSIONAL

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## ABSTRACT

Integral is a concept of continuous addition in mathematics. In the problem of calculus, integral include the main operations used in calculations. One of the integral aplications in real problems is to calculate the volume of a rotating object. The object is 2 dimensional object than is rotated be 3 dimensional based its rotary axes. The first step is to draw a graph or curve of an equation given in the Cartesian plane and its boundaries. Then determine the concept of rotation about the y-axis or x-axis. Furthermore, one must be able to understand well the steps in calculating the volume of rotating object with an integral.

***Keywords*** **:** *Rotary Object Volume, Disc Integration Method, Applied Integral, Applied Calculus.*

## ABSTRAK

Integral adalah sebuah konsep penjumlahan yang berlanjut dalam matematika. Integral juga merupakan operasi utama yang digunakan dalam penghitungan dalam masalah kalkulus. Salah satu aplikasi integral dalam masalah nyata adalah untuk menghitung volume benda putar. Benda yang dimaksud adalah benda 2 dimensi kemudian diputar menjadi benda 3 dimensi berdasarkan sumbu putarnya. Langkah pertama adalah menggambar grafik atau disebut kurva dari sebuah persamaan yang diberikan dalam diagram Cartesius dan juga batas-batasnya. Kemudian objek dalam kurva tersebut diputar mengelilingi sumbu-*y* atau sumbu-*x*. Selanjutnya, langkah yang harus dipahami yaitu menghitung volume benda putar dengan menggunakan operasi integral.

## INTRODUCTION

Mathematics is one of the materials studied from elementary to university education (Abadi, 2020). It is also one of the sciences that supports the development of science, technology, and communication whose development is very fast in the current era. Mathematics is divided into several fields, including Algebra, Calculus, Statistics, and Arithmetic. And in several fields of education, especially the City Planning and Actuarial Planning program, calculus courses are mandatory material that must be taken by every student. In calculus there is material on functions, integrals and derivatives (Mallala,2021). Integral material is a basic material to hone logic and analysis for a student who needs accuracy and precise analysis (Mariko, 2019).

In a life, there are several problems that can be solved using mathematical models, for example the growth rate, waves, calculating the area, calculating the volume of objects, and the others. This is what is usually called applied mathematics. Launching the development of science today, applied mathematics is needed in society. The analytical methods in applied mathematics is integral.

Integral is an operation that is the inverse of the derivative. Integral is still developing theoretically and in application. Integral can be used to determine several quantities. One of which is to determine the length of the curve in the plane. (Imaniyah, et al. 2021). In other side, Application of integral can be used in economics and finance, example the stochastic function (Harini and Sari, 2020). The other applications are widely used to solve various problems. There are applied integral to prove circumference formula (Imaniyah, etc. 2021), to calculating the area, calculating the volume of a rotating object, and so on. Integral method even used to solve the solidification problem of liquid tin and lead metals

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*Volume 02 No 02 (2022)*

(Canzian,2022) and in wave function (Shkolnisky, 2007).

Integral is divided into two, namely definite integral and indefinite integral. An indefinite integral is an integral that has no limit. There are three ways to solve this indefinite integral, namely the usual method, the substitution method, and the partial integral. While the definite integral is an integral that has a limit, both an upper limit and a lower limit. The solution is like an indefinite integral which is then substituted for the limit into the integrated variable. The integration process of this definite integral will be used in the integral application discussed in this study.

In this article, we discussed the application to determining the volume of a rotating body. The volume of a rotary object is the volume of an object obtained from the rotation of a flat plane against a certain line (Rimo, 2018). This is obtained by rotating the area of the plane about the axis of rotation depicted in the Cartesian diagram. There are three solving methods to find the volume of a rotating object, namely the disc integration method, the ring method and the tube shell method. The difference between these three methods lies in the position of the representative of the rectangular band.

This study discusses the application of integrals to the volume of a rotating object. In this article, one method of solving the integral volume of a rotating body is used, namely the disc integration method. The purpose of writing this article is to apply the integral to calculate the volume of a rotating body.

## METHOD

The method used in this research is a literature study which discusses the integral application to determining the volume of a rotating object. The research steps are as follows:

1. Measure each part of the graph to determine points in the equation.
2. Define function.
3. Determine the limit of integration for *x*-axis and *y*.
4. Calculate the volume of an object using integral definite.

### Volume of Rotating Object Against the *x*-Axis

The area $D = \{(x, y)|a, 0\ y \leq (x)\}$ as shown in figure 1, then rotated about the *x*-axis as shown in figure 2.

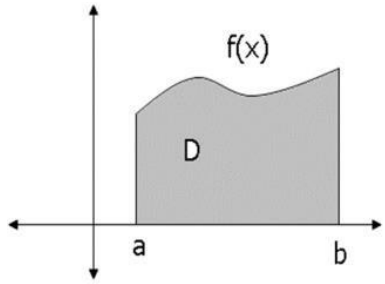


Figure 1

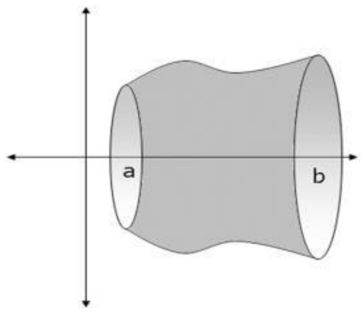


Figure 2

The volume of rotating object can be calculated using the integral with slice approach, add and take the limit. If the slice of approach shaped rectangular (Figure 3) with the high $f(x)$ and base Δx and rotated against *x*-axis will obtained a circle disc with heavy Δx and the radius $f(x)$, so

$$\Delta V \approx \pi f^2(x)\Delta x$$

Then the integrated into

$$V = \pi \int_a^b f^2(x)\ dx$$

The radius is equal to the distance from this axis of rotation to the boundary of the region (figure 4).

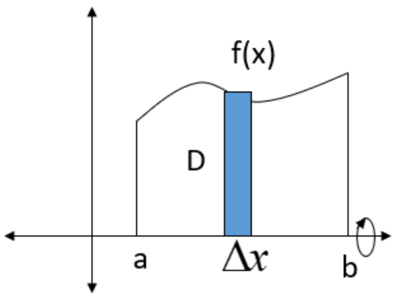


Figure 3

*E-ISSN:* 2775-8486
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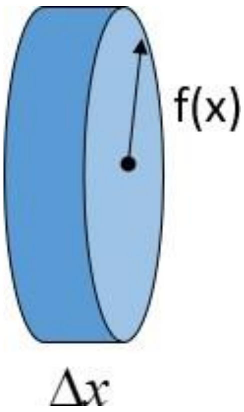


Figure 4

**Volume of Rotating Object Against the *y*-Axis**

If rotated against $y$-axis, so the area of $D = \{(x,y)|c \leq y \leq d, 0 \leq x \leq g(y)\}$ as figure 5, then rotated against $y$-axis as figure 6.

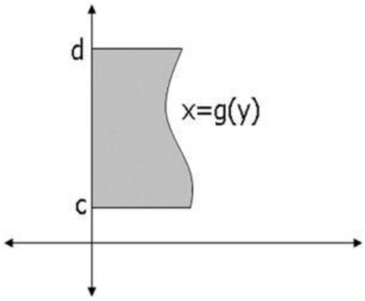


Figure 5

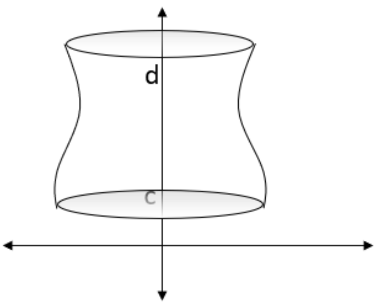


Figure 6

Calculating of the volume of rotating object can be used the integral as previously. If the slice of approach shaped rectangular (Figure 7) with the high $g(y)$ and base Δy. It is rotated against $y$-axis. Then we obtained a circle disc with heavy Δx and the radius $f(x)$, so

$$\Delta V \approx \pi g^2(y)\Delta y$$

So, the integration became

$$V = \pi \int_c^d g^2(y)\ dy$$

The radius is equal to the distance from this axis of rotation to the boundary of the region (figure 8).

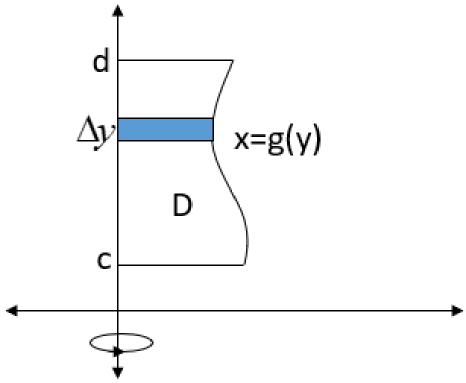


Figure 7

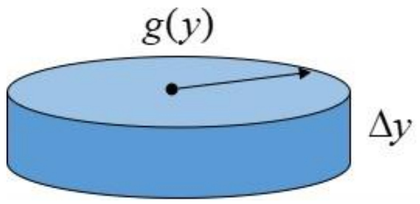


Figure 8

**DISCUSSION**

See the area in the figure 9. That is bounded by the $x$-axis, line $y_1$, and $x = 6$ as below..

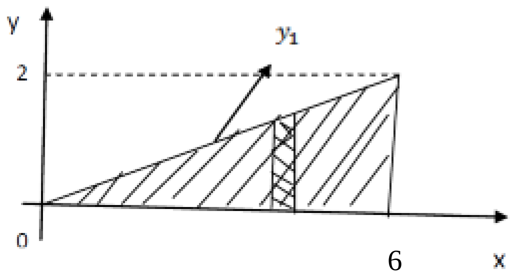


Figure 9

Calculating the volume can be used by the integral with the following steps:

1. The first, determined the equation of the line $y_1$. The line passes through the points (0,0) and (6,2). To determine the equation, used the formula

$$\frac{y - y_1}{x - x_1} = \frac{y_2 - y_1}{x_2 - x_1}$$

$$\frac{y - 0}{x - 0} = \frac{2 - 0}{6 - 0}$$

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$$\frac{y}{x} = \frac{2}{6}$$
$$y = \frac{2}{6}x = \frac{1}{3}x$$

So, the equation of the $y_1$ is obtained $y_1 = \frac{1}{3}x$.

2. Make a representative tape perpendicular to the axis of rotation and the rectangle that is approached by the tape.
3. Finally, the calculating of the volume a rotating object using the integral formula for the volume of a rotating object with a limit of $a = 0$ and $b = 6$.

$$V = \pi \int_0^6 y_1^2 \ dx$$
$$V = \pi \int_0^6 \left(\frac{1}{3}x\right)^2 \ dx$$
$$V = \frac{1}{9}\pi \int_0^6 x^2 \ dx$$
$$V = \frac{1}{9}\pi \left[\frac{1}{3}x^3\right]_0^6$$
$$V = \frac{64}{9}\pi \ unit\ volume$$

## CONCLUSION

From the description above, it can be concluded that calculating the volume of a rotating object using a definite integral with a predetermined limit. In the definite integral, one must know the integration process which includes ordinary, substitution, and partial. One method to calculate the volume of a rotating object is disc integration method and the object can be rotated about the *x*-axes and *y*-axes. In the problem above, it is obtained that volume $\frac{64}{9}\pi$ unit volume from the equation $y_1 = \frac{1}{3}x$. The boundary of that curve is $a = 0$ and $b = 6$ of *x*-axes and rotated by *x*-axes.

The material of integral can be applied in other side, such as the area of both regular and irregular areas, center of gravity, moment, moment of inertia. Therefore, it is also possible to write articles on the application of integral material to other fields.

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