Pi Value Calculating Trigonometric Function

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Abstract— In the present work, I study calculate pi value by trigonometric function sine and tangent. This paper is one approach to calculate the pi value in different way.

Key words: Circle, Minor Arc, Right Angle

I. INTRODUCTION

Pi is related to the circle. So consider the circle

- Draw a circle origin O with radius r units.
- Two lines draw OA and OC, its angle is θ degree.
- $\theta = x \times 10^{n}$ where $0 > x \le 360$ and $n \le 0$.
- Draw a perpendicular CD on line OA.
- ΔOCD, right angle at O in which OC=r units.
- AC is minor arc of a circle with radius r units.
- CD ≈AC

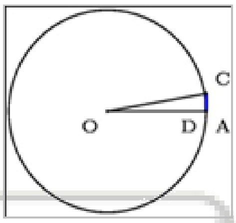

Fig. 1:

A. *Theorem 1: If we decrease the n in θ then CD= AC*

1) *Proof*

a) Iteration 1

Let OC=1 and $\theta = 2\times10^{-3}$

LHS=CD

$$\frac{CD}{OC} = \sin(\theta) \qquad \therefore \frac{Perpendicular}{Hypotenuse} = \sin(\theta)$$

$$CD = OC \times sin(\theta)$$

$$CD = 1 \times sin(2 \times 10^{-3})$$

$$CD = 3.490658503 \times 10^{-5}$$

RHS= AC

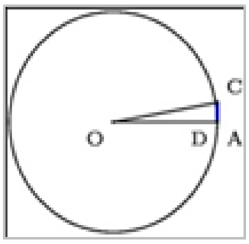

Fig. 2:

$$AC = \frac{\theta}{360} \times 2\pi r$$

$$AC = \frac{2 \times 10^{-3}}{360} \times 2\pi r$$

$$= \frac{0.01256637}{360}$$

$$= 3.490658504 \times 10^{-5}$$

$$CD \approx AC$$

b) Iteration 2

Let OC=1 and $\theta = 2\times10^{-4}$

LHS=CD

$$\frac{CD}{OC} = \sin(\theta) \qquad \therefore \frac{Perpendicular}{Hypotenuse} = \sin(\theta)$$

$$CD = OC \times Sin(\theta)$$

$$CD = 1 \times sin(2 \times 10^{-4})$$

$$CD = 3.490658504 \times 10^{-6}$$

RHS= AC

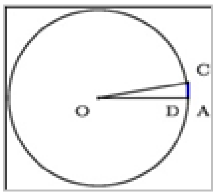

Fig. 3:

$$AC = \frac{2 \times 10^{-4}}{360} \times 2\pi r$$

$$= \frac{2 \times 10^{-4}}{360} \times 2\pi r$$

$$= \frac{1.256637061 \times 10^{-6}}{360}$$

$$= 3.490658504 \times 10^{-6}$$

$$CD = AC$$

So the general form is

$$\frac{x \times 10^{n}}{360} \times 2\pi r = \sin(x \times 10^{n}) \times r \qquad (1)$$

B. *Theorem 2*

Proof that $\pi = \frac{sin(x\times10^{n})\times180}{x\times10^{n}}$ where $\theta = x \times 10^{n}, n \le 0$.

1) *Proof*

we know that

$$\frac{x \times 10^{n}}{360} \times 2\pi r = \sin(x \times 10^{n}) \times r \qquad from\ eq.(1)$$

$$\pi = \frac{\sin(x \times 10^{n}) \times r \times 360}{(x \times 10^{n}) \times 2r}$$

$$\pi = \frac{\sin(x \times 10^{n}) \times 180}{x \times 10^{n}} \qquad (2)$$

C. *Theorem 3*

Proof that $\pi = \frac{tan(x\times10^{n})\times180}{x\times10^{n}}$ where $\theta = x \times 10^{n}, n \le 0$.

Proof: -

$$\pi = \frac{\sin(x \times 10^{n}) \times 180}{x \times 10^{n}} \qquad from\ eq.(2)$$

$$\pi = \frac{\sin(x \times 10^{n}) \times 180}{1 \times (x \times 10^{n})}$$

$$\pi = \frac{\sin(x \times 10^{n}) \times 180}{\cos(x \times 10^{n})\,(x \times 10^{n})} \qquad \therefore \cos(x \times 10^{n}) \approx 1$$

$$\pi = \frac{\sin(x \times 10^{n})}{\cos(x \times 10^{n})} \times \frac{180}{x \times 10^{n}} \qquad \therefore \frac{\sin(\theta)}{\cos(\theta)} = \tan(\theta)$$

$$\pi = \frac{\tan(x \times 10^{n}) \times 180}{x \times 10^{n}} \qquad (3)$$

II. Calculation

$$\pi = \frac{\sin(x \times 10^n) \times 180}{x \times 10^n}$$

x	n	π	Correct decimal places
2	0	3.14095470322508744813956	2
9	-2	3.14159136166175761121326	5
45	-3	3.14159233060775444691765	6
155	-8	3.14159265358979285527036	14
180	-10	3.14159265358979323841096	19
210	-12	3.14159265358979323846263	22
270	-15	3.14159265358979323846264 33832679	28
290	-16	3.14159265358979323846264 33832794	30
1	-14	3.14159265358979323846264 33832795	31

Table 1:

$$\pi = \frac{\tan(x \times 10^n) \times 180}{x \times 10^n}$$

x	n	π	Correct decimal place
2	0	3.14286925425729574503623	2
9	-2	3.14159523744873343003441	5
45	-3	3.14159329955405013000118	5
155	-8	3.14159265358979400484720	14
180	-10	3.14159265358979323856599	18
210	-12	3.14159265358979323846265	22
270	-15	3.14159265358979323846264 33833028	27
290	-16	3.14159265358979323846264 33832798	30
1	-14	3.14159265358979323846264 33832795	31

Table 2:

III. Conclusion

1) This method is calculating pi value by trigonometric function sine and tangent.
2) From the above table we observe that Table1 is efficient for the Table2. In other words can say that $\pi = \frac{\sin(x\times10^n)\times180}{x\times10^n}$ is more efficient.
3) If decrease the n value, we get more correct result in both method.
4) We can apply this method in trigonometry and related to circle.

References

[1] D.R .Sharma, "Trigonometry", 3rd edition, pp. 531-677, Sharma Publication, Jalandhar, 2010.
[2] D.R .Sharma, "Circle", 3rd edition, pp. 769-792, Sharma Publication, Jalandhar, 2010.