

## UNIT – III FOURIER SERIES

### Fourier series

Suppose that a given function  $f(x)$  defined in  $[-\pi, \pi]$  (or)  $[0, 2\pi]$  (or) in any other interval can be expressed as

$$f(x) = \frac{a_0}{2} + \sum_{n=1}^{\infty} (a_n \cos nx + b_n \sin nx)$$

The above series is known as the Fourier series for  $f(x)$  and the constants  $a_0, a_n, b_n$  ( $n=1, 2, 3, \dots$ ) are called Fourier coefficients of  $f(x)$

### Periodic Function:-

A function  $f(x)$  is said to be periodic with period  $T > 0$  if for all  $x$ ,  $f(x+T) = f(x)$ , and  $T$  is the least of such values

Example:- (1)  $\sin x = \sin(x+2\pi) = \sin(x+4\pi) = \dots$  the function  $\sin x$  is periodic with period  $2\pi$ . There is no positive value  $T$ ,  $0 < T < 2\pi$  such that  $\sin(x+T) = \sin x \forall x$

(2) The period of  $\tan x$  is  $\pi$

(3) The period of  $\sin nx$  is  $\frac{2\pi}{n}$  i.e.  $\sin nx = \sin n\left(\frac{2\pi}{n} + x\right)$

### Euler's Formulae:-

The Fourier series for the function  $f(x)$  in the interval  $C \leq x \leq C + 2\pi$  is given by

$$f(x) = \frac{a_0}{2} + \sum_{n=1}^{\infty} (a_n \cos nx + b_n \sin nx)$$

Where  $a_0 = \frac{1}{\pi} \int_C^{C+2\pi} f(x) dx$

$$a_n = \frac{1}{\pi} \int_C^{C+2\pi} f(x) \cos nx \cdot dx \text{ and}$$

$$b_n = \frac{1}{\pi} \int_C^{C+2\pi} f(x) \sin nx \cdot dx$$

These values of  $a_0, a_n, b_n$  are known as Euler's formulae

Corollary:- If  $f(x)$  is to be expanded as a Fourier series in the interval  $0 \leq x \leq 2\pi$ , put  $C = 0$  then the formulae (1) reduces to

$$a_0 = \frac{1}{\pi} \int_0^{2\pi} f(x) dx \quad a_n = \frac{1}{\pi} \int_0^{2\pi} f(x) \cos nx \cdot dx$$

$$b_n = \frac{1}{\pi} \int_0^{2\pi} f(x) \sin nx \cdot dx$$

Corollary 2:- If  $f(x)$  is to be expanded as a Fourier series in  $[-\pi, \pi]$  put  $C = -\pi$ , the interval becomes  $-\pi \leq x \leq \pi$  and the formulae (1) reduces to

# Fourier Series Mathematics For Science And Technology

**S Ashworth**



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## **Table of Contents Fourier Series Mathematics For Science And Technology**

1. Understanding the eBook Fourier Series Mathematics For Science And Technology
  - The Rise of Digital Reading Fourier Series Mathematics For Science And Technology
  - Advantages of eBooks Over Traditional Books
2. Identifying Fourier Series Mathematics For Science And Technology
  - Exploring Different Genres
  - Considering Fiction vs. Non-Fiction
  - Determining Your Reading Goals
3. Choosing the Right eBook Platform
  - Popular eBook Platforms
  - Features to Look for in an Fourier Series Mathematics For Science And Technology
  - User-Friendly Interface
4. Exploring eBook Recommendations from Fourier Series Mathematics For Science And Technology
  - Personalized Recommendations
  - Fourier Series Mathematics For Science And Technology User Reviews and Ratings
  - Fourier Series Mathematics For Science And Technology and Bestseller Lists
5. Accessing Fourier Series Mathematics For Science And Technology Free and Paid eBooks
  - Fourier Series Mathematics For Science And Technology Public Domain eBooks
  - Fourier Series Mathematics For Science And Technology eBook Subscription Services

- Fourier Series Mathematics For Science And Technology Budget-Friendly Options
- 6. Navigating Fourier Series Mathematics For Science And Technology eBook Formats
  - ePub, PDF, MOBI, and More
  - Fourier Series Mathematics For Science And Technology Compatibility with Devices
  - Fourier Series Mathematics For Science And Technology Enhanced eBook Features
- 7. Enhancing Your Reading Experience
  - Adjustable Fonts and Text Sizes of Fourier Series Mathematics For Science And Technology
  - Highlighting and Note-Taking Fourier Series Mathematics For Science And Technology
  - Interactive Elements Fourier Series Mathematics For Science And Technology
- 8. Staying Engaged with Fourier Series Mathematics For Science And Technology
  - Joining Online Reading Communities
  - Participating in Virtual Book Clubs
  - Following Authors and Publishers Fourier Series Mathematics For Science And Technology
- 9. Balancing eBooks and Physical Books Fourier Series Mathematics For Science And Technology
  - Benefits of a Digital Library
  - Creating a Diverse Reading Collection Fourier Series Mathematics For Science And Technology
- 10. Overcoming Reading Challenges
  - Dealing with Digital Eye Strain
  - Minimizing Distractions
  - Managing Screen Time
- 11. Cultivating a Reading Routine Fourier Series Mathematics For Science And Technology
  - Setting Reading Goals Fourier Series Mathematics For Science And Technology
  - Carving Out Dedicated Reading Time
- 12. Sourcing Reliable Information of Fourier Series Mathematics For Science And Technology
  - Fact-Checking eBook Content of Fourier Series Mathematics For Science And Technology
  - Distinguishing Credible Sources
- 13. Promoting Lifelong Learning
  - Utilizing eBooks for Skill Development
  - Exploring Educational eBooks
- 14. Embracing eBook Trends

- Integration of Multimedia Elements
- Interactive and Gamified eBooks

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