

ELIMINATION OF ARBITRARY CONSTANTS AND FAMILY OF CURVES

CHAPTER 1
ELIMINATION OF ARBITRARY CONSTANTS

1. $x^2 - 2x^2y + c$

$$2x^2y - 2x^2y - 2y(2x^2y) + c = 0$$

$$2x^2y - 2x^2y - 4xy^2 + c = 0$$

divide by $2x$.

$$x^2y - 2xy^2 - 2xy = 0$$

$$\therefore (x+2y)dx - 2xy = 0 \quad \text{ans.}$$

2. $y \sin x - xy^2 + c$

$$y(\cos x dx) + dx dy - 2xy dy = 0$$

$$\therefore y^2 dx = 0$$

$$y^2(\cos x dx) - y^2 dx + dx dy - 2xy dy = 0$$

$$\therefore y^2(\cos x + y)dx + (dx dy - 2xy dy) = 0$$

ans.

3. $x^2y + 1 + c$

$$x^2 dy + 2xy dx = 0 + c dx$$

divide by dx .

$$\frac{d^2y}{dx^2} + 2xy = c$$

multiply by x .

$$x^2y = 1 + x^2 \left[\frac{d^2y}{dx^2} + 2xy \right] = c$$

$$x^2y = 1 + x^2 \frac{d^2y}{dx^2} + 2x^2y$$

$$x^2y dx = dx + x^2 dy + 2x^2y dx$$

$$dx + x^2 dy + 2x^2y dx - x^2y dx = 0$$

$$\therefore dx + x^2 dy + x^2y dx = 0$$

$$\therefore (x^2y + 1)dx + x^2 dy = 0 \quad \text{ans.}$$

4. $cy^2 + x^2y$

$$\frac{x^2y}{y^2} = c$$

$$\frac{x^2(dx + ydy) - (x^2y)dy}{(y^2)^2} = 0$$

$$2xy^2 dx + x^2 dy - 2xy^2 dy - 2y^3 dy = 0$$

divide by y .

$$2xy dx + x^2 dy - 2xy dy - 2y^2 dy = 0$$

$$\therefore 2xy dx - 2y^2 dy = 0$$

ans.

5. $x = A \sin(\omega t + \phi)$; ω is a parameter not to be elim.

$$\frac{dx}{dt} = A \omega \cos(\omega t + \phi)$$

$$\frac{d^2x}{dt^2} = -A \omega^2 \sin(\omega t + \phi)$$

$$\therefore -A \omega^2 \sin(\omega t + \phi)$$

$$\text{but } x = A \sin(\omega t + \phi)$$

$$\therefore \frac{d^2x}{dt^2} = -\omega^2 x$$

$$\therefore \frac{d^2x}{dt^2} + \omega^2 x = 0 \quad \text{ans.}$$

6. $x = C_1 \cos(\omega t) + C_2 \sin(\omega t)$; ω is a parameter.

$$\frac{dx}{dt} = -C_1 \omega \sin(\omega t) + C_2 \omega \cos(\omega t)$$

$$\frac{d^2x}{dt^2} = -C_1 \omega^2 \cos(\omega t) - C_2 \omega^2 \sin(\omega t)$$

$$= -\omega^2 (C_1 \cos(\omega t) + C_2 \sin(\omega t))$$

$$\therefore \frac{d^2x}{dt^2} = -\omega^2 x$$

$$\therefore \frac{d^2x}{dt^2} + \omega^2 x = 0 \quad \text{ans.}$$

7. $y = C_1 e^{2t} + C_2 e^{-2t}$

$$y' = 2C_1 e^{2t} - 2C_2 e^{-2t}$$

$$\therefore y'' = 4C_1 e^{2t} + 4C_2 e^{-2t}$$

8. $y = A e^{\frac{x}{2}}$; A is a parameter, to be eliminated.

$$y' = \frac{A}{2} e^{\frac{x}{2}} \therefore 2y = y'$$

$$\therefore y'' = 2y' = \frac{2}{y} y^2 = \frac{2y^2}{y} \quad \text{ans.}$$

9. $y^2 = 4ax$

$$2y dy = 4a dx$$

$$\therefore 2y = \frac{d^2y}{dx^2} x$$

multiply by x .

$$y^2 = \left(\frac{d^2y}{dx^2} x \right) x$$

$$y^2 dx = 2xy dx$$

$$\therefore y^2 dx - 2xy dx = 0 \quad \text{ans.}$$

10. $y = Ax^2 + Bx + C$

$$y' = 2Ax + B = 0$$

$$y'' = 2A = 0$$

$$y'' = 0 \quad \text{ans.}$$

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Table of Contents Rainville Solution Manual

1. Understanding the eBook Rainville Solution Manual
 - The Rise of Digital Reading Rainville Solution Manual
 - Advantages of eBooks Over Traditional Books
2. Identifying Rainville Solution Manual
 - 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 Rainville Solution Manual
 - User-Friendly Interface
4. Exploring eBook Recommendations from Rainville Solution Manual
 - Personalized Recommendations

- Rainville Solution Manual User Reviews and Ratings
- Rainville Solution Manual and Bestseller Lists
- 5. Accessing Rainville Solution Manual Free and Paid eBooks
 - Rainville Solution Manual Public Domain eBooks
 - Rainville Solution Manual eBook Subscription Services
 - Rainville Solution Manual Budget-Friendly Options
- 6. Navigating Rainville Solution Manual eBook Formats
 - ePub, PDF, MOBI, and More
 - Rainville Solution Manual Compatibility with Devices
 - Rainville Solution Manual Enhanced eBook Features
- 7. Enhancing Your Reading Experience
 - Adjustable Fonts and Text Sizes of Rainville Solution Manual
 - Highlighting and Note-Taking Rainville Solution Manual
 - Interactive Elements Rainville Solution Manual
- 8. Staying Engaged with Rainville Solution Manual
 - Joining Online Reading Communities
 - Participating in Virtual Book Clubs
 - Following Authors and Publishers Rainville Solution Manual
- 9. Balancing eBooks and Physical Books Rainville Solution Manual
 - Benefits of a Digital Library
 - Creating a Diverse Reading Collection Rainville Solution Manual
- 10. Overcoming Reading Challenges
 - Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
- 11. Cultivating a Reading Routine Rainville Solution Manual
 - Setting Reading Goals Rainville Solution Manual
 - Carving Out Dedicated Reading Time
- 12. Sourcing Reliable Information of Rainville Solution Manual
 - Fact-Checking eBook Content of Rainville Solution Manual

- 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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