

Solving for $\int e^{0.4x} \cos 2x \, dx$, we have

$$\int e^{0.4x} \cos 2x \, dx = \frac{5 e^{0.4x} \cos 2x + 25 e^{0.4x} \sin 2x}{52}.$$

To obtain the general solution, we multiply this integral by 3, add the constant of integration, and solve for v . We obtain the general solution

$$v(x) = k e^{-0.4x} + \frac{15}{52} \cos 2x + \frac{75}{52} \sin 2x.$$

(b) The solution of the associated homogeneous equation is

$$v_h(x) = e^{-0.4x}.$$

We guess

$$v_p(x) = \alpha \cos 2x + \beta \sin 2x$$

for the a solution to the nonhomogeneous equation and solve for α and β . Substituting this guess into the differential equation, we obtain

$$-2\alpha \sin 2x + 2\beta \cos 2x + 0.4\alpha \cos 2x + 0.4\beta \sin 2x = 3 \cos 2x.$$

Collecting sine and cosine terms, we get the system of equations

$$\begin{cases} -2\alpha + 0.4\beta = 0 \\ 0.4\alpha + 2\beta = 3. \end{cases}$$

Using the fact that $0.4 = 2/5$, we solve this system of equations and obtain

$$\alpha = \frac{15}{52} \quad \text{and} \quad \beta = \frac{75}{52}.$$

The general solution of the original nonhomogeneous equation is

$$v(x) = k e^{-0.4x} + \frac{15}{52} \cos 2x + \frac{75}{52} \sin 2x.$$

Both methods require quite a bit of computation. If we use an integrating factor, we must do a complicated integral, and if we use the guessing technique, we have to be careful with our algebra.

22. (a) Note that

$$\frac{d\mu}{dt} = \mu(t)(-a(t))$$

by the Fundamental Theorem of Calculus. Therefore, if we rewrite the differential equation as

$$\frac{dy}{dt} - a(t)y = b(t)$$

and multiply the left-hand side of this equation by $\mu(t)$, the left-hand side becomes

$$\begin{aligned} \mu(t) \frac{dy}{dt} - \mu(t)a(t)y &= \mu(t) \frac{dy}{dt} + \frac{d\mu}{dt}y \\ &= \frac{d(\mu y)}{dt}. \end{aligned}$$

Consequently, the function $\mu(t)$ satisfies the requirements of an integrating factor.

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S. J. Farlow



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Table of Contents Solution Manual For Differential Equations Paul Blanchard

1. Understanding the eBook Solution Manual For Differential Equations Paul Blanchard
 - The Rise of Digital Reading Solution Manual For Differential Equations Paul Blanchard
 - Advantages of eBooks Over Traditional Books
2. Identifying Solution Manual For Differential Equations Paul Blanchard
 - 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 Solution Manual For Differential Equations Paul Blanchard
 - User-Friendly Interface
4. Exploring eBook Recommendations from Solution Manual For Differential Equations Paul Blanchard
 - Personalized Recommendations
 - Solution Manual For Differential Equations Paul Blanchard User Reviews and Ratings
 - Solution Manual For Differential Equations Paul Blanchard and Bestseller Lists

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