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**Exercise 29, Linear Algebra: A Modern Introduction, 4th Edition**

NEXT QUESTION



Linear Algebra: A Modern Introduction, 4th Edition, Chapter 6: Vector Spaces

**Exercise 29, Page 514****Exercise 29 Answer****Step by step explanation**

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**Tip**

- $D$  is differential operator.
- $D^{-1}$  is anti-differentiation that is integral.

**Explanation**

- We will take  $W = \text{span}(e^{2x} \cos x, e^{2x} \sin x)$  be the subspace of  $D$ .
- $\beta = \{e^{2x} \cos x, e^{2x} \sin x\}$  be the basis of  $W$ .

- With the help of basis we will find  $[D]_{\beta}$ .
- By the use of theorem 6.28, we get  $[D]_{\beta}^{-1}$ .
- With the help of theorem 6.26, we get the desired integral

### Step 1 of 2

Let,  $W = \text{span}(e^{2x} \cos x, e^{2x} \sin x)$  be the subspace of  $D$

$\beta = \{e^{2x} \cos x, e^{2x} \sin x\}$  is basis of  $W$ .

$$D(e^{2x} \cos x) = 2e^{2x} \cos x - e^{2x} \sin x$$

$$D(e^{2x} \sin x) = 2e^{2x} \sin x + e^{2x} \cos x$$

Thus,

$$[D(e^{2x} \cos x)]_{\beta} = \begin{bmatrix} 2 \\ -1 \end{bmatrix}$$

$$[D(e^{2x} \sin x)]_{\beta} = \begin{bmatrix} 1 \\ 2 \end{bmatrix}$$

Then,

$$[D]_{\beta} = \begin{bmatrix} 2 & 1 \\ -1 & 2 \end{bmatrix}$$

By theorem 6.28, linear transformation  $D$  is invertible

$$\begin{aligned} [D^{-1}]_{\beta} &= ([D]_{\beta})^{-1} \\ &= \begin{bmatrix} 2 & 1 \\ -1 & 2 \end{bmatrix}^{-1} \\ &= \begin{bmatrix} 2 & -1 \\ 5 & 5 \\ 1 & 2 \\ 5 & 5 \end{bmatrix} \end{aligned}$$

### Step 2 of 2

$$[e^{2x} \cos x - 2e^{2x} \sin x]_{\beta} = \begin{bmatrix} 1 \\ -2 \end{bmatrix}$$

Then, By theorem 6.26,

$$\begin{aligned} \left[ \int (e^{2x} \cos x - 2e^{2x} \sin x) dx \right]_{\beta} &= [D^{-1}(e^{2x} \cos x - 2e^{2x} \sin x)]_{\beta} \\ &= [D^{-1}]_{\beta} [(e^{2x} \cos x - 2e^{2x} \sin x)]_{\beta} \\ &= \begin{bmatrix} 2/5 & -1/5 \\ 1/5 & 2/5 \end{bmatrix} \begin{bmatrix} 1 \\ -2 \end{bmatrix} \\ &= \begin{bmatrix} 4 \\ 5 \\ -3 \\ 5 \end{bmatrix} \end{aligned}$$

$$\int (e^{2x} \cos x - 2e^{2x} \sin x) dx = \frac{4}{5} e^{2x} \cos x - \frac{3}{5} e^{2x} \sin x + C$$

### ◆ Final Answer



$$\int (e^{2x} \cos x - 2e^{2x} \sin x) dx = \frac{4}{5} e^{2x} \cos x - \frac{3}{5} e^{2x} \sin x + C$$

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