RH 1.9

MATH 5, Jones

Tejas Patel

Refrigerator Homework

10

$AD = I$
$A^{-1}(AD) = A^{-1}I$
$(A^{-1}A)D = A^{-1}I$
$ID = A^{-1}$
$D = A^{-1}$

24

$(B - C)D = 0$
$(B - C)DD^{-1} = 0D^{-1}$
$(B - C)I = 0$
$B - C = 0$
$B = C$

29

$C^{-1}(A + X)B^{-1} = I_n$
$(A + X)B^{-1} = CI_n = C$
$A + X = CB$
$X = CB - A$

30

a: B is invertible because it appears in an equation where both sides represent the inverse of an invertible matrix. If B were not invertible, the equation would not properly define an inverse on the left-hand side. b: $(A - AX)^{-1} = X^{-1}B$.
$A - AX = B^{-1}X$.
$A = AX + B^{-1}X$.
$A = (A + B^{-1})X$.
$X = (A + B^{-1})^{-1}A$

32

Because if its invertible its linearly independent, meaning it spans $\mathbb{R}^n$. Simple stuff really

Computer Homework: Next 10 Pages

Question list

Question 1
Question 2
Question 3
Question 4
Question 5
Question 6
Question 7
Question 8
Question 9
Question 10

Find the inverse of the matrix.

$$\begin{bmatrix} 8 & 5 \\ 2 & 6 \end{bmatrix}$$

Select the correct choice below and, if necessary, fill in the answer box to complete your choice.

A. The inverse matrix is $\begin{bmatrix} \frac{3}{19} & -\frac{5}{38} \\ -\frac{1}{19} & \frac{4}{19} \end{bmatrix}$.

(Type an integer or simplified fraction for each matrix element.)

B. The matrix is not invertible.

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2.2 RH | Review Homework

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Review Homework: Section 2.2 Homework Question 2, 2.2.10

HW Score: 80%, 8 of 10 points
Points: 0.8 of 1

Close

Question list

- Question 1
- Question 2
- Question 3
- Question 4
- Question 5
- Question 6
- Question 7
- Question 8
- Question 9
- Question 10

Use matrix algebra to show that if A is invertible and D satisfies $AD = I$, then $D = A^{-1}$.

Choose the correct answer below.

A. Add A^{-1} to both sides of the equation $AD = I$ to obtain $AD + A^{-1} = I + A^{-1}$, $DI = A^{-1}$, and $D = A^{-1}$.

B. Left-multiply each side of the equation $AD = I$ by A^{-1} to obtain $A^{-1}AD = A^{-1}I$, $ID = A^{-1}$, and $D = A^{-1}$.

C. Right-multiply each side of the equation $AD = I$ by A^{-1} to obtain $ADA^{-1} = IA^{-1}$, $DI = A^{-1}$, and $D = A^{-1}$.

D. Add A^{-1} to both sides of the equation $AD = I$ to obtain $A^{-1} + AD = A^{-1} + I$, $ID = A^{-1}$, and $D = A^{-1}$.

Textbook Ask my instructor Try again Next

Question list
Question 1
Question 2
Question 3
Question 4
Question 5
Question 6
Question 7
Question 8
Question 9
Question 10

Suppose A, B, and C are invertible $n \times n$ matrices. Show that ABC is also invertible by introducing a matrix D such that $(ABC)D = I$ and $D(ABC) = I$.

It is assumed that A, B, and C are invertible matrices. What does this mean?

- A. A^{-1}, B^{-1}, and C^{-1} are all not equal to the identity matrix.
- B. A^{-1}, B^{-1}, and C^{-1} are all equal to the identity matrix.
- C. A^{-1}, B^{-1}, and C^{-1} exist.
- D. A^{-1}, B^{-1}, and C^{-1} all have determinants equal to zero.

Now assume that $(ABC)D = I$. Since A, B, and C are invertible, this equation can be solved for D. Which operation will remove A from the left side of this equation?

- A. Left multiply both sides of the equation by A^{-1}.
- B. Subtract A^{-1} from both sides of the equation.
- C. Right multiply both sides of the equation by A^{-1}.
- D. Subtract A from both sides of the equation.

Perform the operation determined in the previous step and simplify both sides of the equation.

$(BC)D = A^{-1}$

(Type the terms of your expression in the same order as they appear in the original expression.)

Perform similar operations to remove B and C from the left side of the equation to solve for D.

$D = C^{-1}B^{-1}A^{-1}$

Thus, D satisfying $(ABC)D = I$ exists. Why does the expression for D found above also satisfy $D(ABC) = I$, thereby showing that ABC is invertible? Select the correct choice below and, if necessary, fill in the answer box within your choice.

- A. After substituting the expression for D, taking the inverse of both sides of the equation results in the equation $I = ABCD$.
- B. After substituting the expression for D, right multiplying the product by ☐ results in the equation $I = ABCD$.
- C. After substituting the expression for D, left multiplying the product by ☐ results in the equation $I = ABCD$.
- D. After substituting the expression for D, the product DABC simplifies to I by repeated application of the associative property and the definition of inverse matrices.

Solve the equation AB = BC for A, assuming that A, B, and C are square matrices and B is invertible.

$A = BCB^{-1}$ (Simplify your answer.)

Question list

Question 1
Question 2
Question 3
Question 4
Question 5
Question 6
Question 7
Question 8
Question 9
Question 10

Suppose A, B, and X are $n \times n$ matrices with A, X, and $A - AX$ invertible, and suppose that $(A - AX)^{-1} = X^{-1}B$. Complete parts (a) and (b) below.

a. Explain why B is invertible. Choose the correct answer below.

- A. Since $X^{-1}B$ is equal to $(A - AX)^{-1}$ and $(A - AX)^{-1}$ is invertible, $X^{-1}B$ is also invertible. Since $X^{-1}B$ is invertible and X^{-1} is invertible, B must be invertible.
- B. Solving the equation $(A - AX)^{-1} = X^{-1}B$ for B yields $X(A - AX)^{-1} = B$. Since X is invertible and $(A - AX)^{-1}$ is invertible, the product $X(A - AX)^{-1} = B$ is also invertible.
- C. Solving the equation $(A - AX)^{-1} = X^{-1}B$ for B yields $(A - AX)^{-1}X = B$. Since X is invertible and $(A - AX)^{-1}$ is invertible, the product $(A - AX)^{-1}X = B$ is also invertible.
- D. Multiply both sides of equation $(A - AX)^{-1} = X^{-1}B$ by B^{-1} to obtain $X^{-1} = (A - AX)^{-1}B^{-1}$. Now multiply both sides by $(A - AX)$ to obtain the equation $B^{-1} = (A - AX)X^{-1}$. Thus, the inverse of B exists and B must be invertible.

b. Solve the equation $(A - AX)^{-1} = X^{-1}B$ for X.

$X = (A + B^{-1})^{-1}A$

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Review Homework: **Section 2.2 Homework**

Question 6, 2.2.31

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Close

Question list

- Question 1
- Question 2
- Question 3
- Question 4
- Question 5
- Question 6
- Question 7
- Question 8
- Question 9
- Question 10

Explain why the columns of an $n \times n$ matrix A are linearly independent when A is invertible.

Choose the correct answer below.

A. If A is invertible, then A has an inverse matrix A^{-1}. Since $AA^{-1} = A^{-1}A$, A must have linearly independent columns.

B. If A is invertible, then A has an inverse matrix A^{-1}. Since $AA^{-1} = I$, A must have linearly independent columns.

C. If A is invertible, then for all $\mathbf{x}$ there is a $\mathbf{b}$ such that $A\mathbf{x} = \mathbf{b}$. Since $\mathbf{x} = \mathbf{0}$ is a solution of $A\mathbf{x} = \mathbf{0}$, the columns of A must be linearly independent.

D. If A is invertible, then the equation $A\mathbf{x} = \mathbf{0}$ has the unique solution $\mathbf{x} = \mathbf{0}$. Since $A\mathbf{x} = \mathbf{0}$ has only the trivial solution, the columns of A must be linearly independent.

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Suppose A is $n \times n$ and the equation $Ax = 0$ has only the trivial solution. Explain why A has n pivot columns and A is row equivalent to I_n.

Choose the correct answer below.

- A. Suppose A is $n \times n$ and the equation $Ax = 0$ has only the trivial solution. Then there are no free variables in this equation, thus A has n pivot columns. Since A is square and the n pivot positions must be in different rows, the pivots in an echelon form of A must be on the main diagonal. Hence A is row equivalent to the $n \times n$ identity matrix, I_n.
- B. Suppose A is $n \times n$ and the equation $Ax = 0$ has only the trivial solution. Then there are no free variables in this equation, thus A has n pivot columns. Since A is square and the n pivot positions must be in different rows, the pivots in A must be on the main diagonal. Hence A is the $n \times n$ identity matrix, I_n.
- C. Suppose A is $n \times n$ and the equation $Ax = 0$ has only the trivial solution. Then there are n free variables in this equation, thus A has n pivot columns. Since A is square and the n pivot positions must be in different rows, the pivots in an echelon form of A must be on the main diagonal. Hence A is row equivalent to the $n \times n$ identity matrix, I_n.

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Tejas Patel

Review Homework: Section 2.2 Homework

Question 8, 2.2.34

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Close

Question list

- Question 1
- Question 2
- Question 3
- Question 4
- Question 5
- Question 6
- Question 7
- Question 8
- Question 9
- Question 10

Suppose A is $n \times n$ and the equation $Ax = b$ has a solution for each b in $\mathbb{R}^n$. Explain why A must be invertible. [Hint: Is A row equivalent to I_n?]

Choose the correct answer below.

- A. If the equation $Ax = b$ has a solution for each b in $\mathbb{R}^n$, then A has a pivot position in each row. Since A is square, the pivots must be on the diagonal of A. It follows that A is row equivalent to I_n. Therefore, A is invertible.
- B. If the equation $Ax = b$ has a solution for each b in $\mathbb{R}^n$, then A has one pivot position. It follows that A is row equivalent to I_n. Therefore, A is invertible.
- C. If the equation $Ax = b$ has a solution for each b in $\mathbb{R}^n$, then A has a pivot position in each row. Since A is square, the pivots must be on the diagonal of A. It follows that A is I_n. Therefore, A is invertible.
- D. If the equation $Ax = b$ has a solution for each b in $\mathbb{R}^n$, then A does not have a pivot position in each row. Since A is square, and I_n is square, A is row equivalent to I_n. Therefore, A is invertible.

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Question list

Question 1
Question 2
Question 3
Question 4
Question 5
Question 6
Question 7
Question 8
Question 9
Question 10

Find the inverse of the given matrix, if it exists.

$$A = \begin{bmatrix} 1 & -2 & 1 \\ 2 & -3 & 1 \\ 4 & -2 & -2 \end{bmatrix}$$

Find the inverse. Select the correct choice below and, if necessary, fill in the answer box to complete your choice.

A. $A^{-1} =$ ☐
(Type an integer or decimal for each matrix element.)

B. The matrix A does not have an inverse.

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Question list

Let $A = \begin{bmatrix} 1 & 5 \\ 1 & 6 \\ 1 & 11 \end{bmatrix}$. Construct a 2×3 matrix C (by trial and error) using only 1, -1, and 0 as entries, such that $CA = I_2$. Compute AC and note that $AC \neq I_3$.

$C = \begin{bmatrix} 1 & 1 & -1 \\ -1 & 1 & 0 \end{bmatrix}$

$AC = \begin{bmatrix} -4 & 6 & -1 \\ -5 & 7 & -1 \\ -10 & 12 & -1 \end{bmatrix}$

(Simplify your answer.)