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DETERMINANTS AND INVERSES OF MATRICES

Finding the inverse of a matrix is very important in many areas of science. For example, decrypting a coded message uses the inverse of a matrix. We use determinants to answer this problem and find the inverse. To find the determinant and inverse of a matrix, it must be a *square* matrix, for example a 2x2 or 3x3. The determinant of a 2x2 matrix can easily be found by the following:

Given matrix A = $\begin{bmatrix} a & b \\ c & d \end{bmatrix}$, the determinant of A, or det(A) = $ad - bc$

EXAMPLE: Find the determinant of B = $\begin{bmatrix} 4 & -2 \\ 1 & -3 \end{bmatrix}$

det(b) = (4)(-3) — (-2)(1) = -12 — -2 = -12 + 2 = **-10**

Determinants are used to find the inverses of matrices. The inverse of a matrix exists if and only if the determinant ≠ 0. In this case, the inverse of A **does** exist because -10 ≠ 0.

Find the determinant and state whether the inverse exists.

1. B = $\begin{bmatrix} 4 & -2 \\ 5 & -1 \end{bmatrix}$ Determinant: 6 Inverse? yes

$-4 - -10 = -4+10 = 6$

2. C = $\begin{bmatrix} -5 & -5 \\ -3 & 5 \end{bmatrix}$ Determinant: -40 Inverse? yes

$-25 - 15$

3. D = $\begin{bmatrix} 3 & 3 \\ -4 & -2 \end{bmatrix}$ Determinant: 6 Inverse? yes

$-6 - -12 = -6 + 12$

4. E = $\begin{bmatrix} 2 & -3 \\ 2 & -3 \end{bmatrix}$ Determinant: 0 Inverse? no

$-6 - -6 = -6 + 6 = 0$

For square matrices larger than 2x2, it is easier to use a calculator to find the determinants.

- Follow the steps from yesterday to enter the matrices into the calculator
- Go to the Matrix Menu and use ▶ (right arrow) over to **MATH**
- **ENTER** for 1: det(
- Go to the Matrix Menu and under **NAMES**, press **ENTER** for the matrix you would like to find the determinant for
- **ENTER**

Find the determinant and state whether the inverse exists.

5. $F = \begin{bmatrix} -1 & 1 & 4 \\ -6 & 3 & 4 \\ 2 & 0 & 6 \end{bmatrix}$ Determinant: 2 Inverse? yes

6. $G = \begin{bmatrix} -3 & 4 & 1 \\ -2 & 6 & -4 \\ -5 & 4 & 5 \end{bmatrix}$ Determinant: 4 Inverse? yes

7. $H = \begin{bmatrix} -1 & -5 & -3 \\ 2 & 1 & -1 \\ -1 & -5 & -3 \end{bmatrix}$ Determinant: 0 Inverse? no

8. $I = \begin{bmatrix} 3 & 2 & -2 \\ -2 & -3 & -5 \\ -5 & -4 & 1 \end{bmatrix}$ Determinant: −1 Inverse? yes

We can use our calculator to find the inverses of matrices. To find the inverse of a matrix,

- Select the matrix from the Matrix Menu under **NAMES** and press **ENTER**
- Press the x^{-1} key and **ENTER**

Find the inverses for matrices A-I in this packet (most should already be in your calculator)

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

$B^{-1} =$ $\begin{bmatrix} -.167 & .333 \\ -.833 & .667 \end{bmatrix}$

$C^{-1} =$ $\begin{bmatrix} -.125 & -.125 \\ -.075 & .125 \end{bmatrix}$

$D^{-1} =$ $\begin{bmatrix} -.333 & -.5 \\ .667 & .5 \end{bmatrix}$

$E^{-1} =$

$F^{-1} =$ $\begin{bmatrix} 9 & -3 & -4 \\ 22 & -7 & -10 \\ -3 & 1 & 1.5 \end{bmatrix}$

$G^{-1} =$ $\begin{bmatrix} 11.5 & -4 & -5.5 \\ 7.5 & -2.5 & -3.5 \\ 5.5 & -2 & -2.5 \end{bmatrix}$

$H^{-1} =$

$I^{-1} =$ $\begin{bmatrix} 23 & -6 & 16 \\ -27 & 7 & -19 \\ 7 & -2 & 5 \end{bmatrix}$