F15 Exam 2 Problem 1 [Reserved for Score]

Linear Algebra, Dave Bayer

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[1] Find a basis for the subspace V of $\mathbb{R}^4$ spanned by the vectors

$$(1,1,0,1) \qquad (1,0,1,1) \qquad (2,1,1,2) \qquad (3,2,1,3) \qquad (3,1,2,3) \qquad (4,2,2,4)$$

Extend this basis to a basis for $\mathbb{R}^4$.

F17 10:10 Exam 2 Problem 1
Linear Algebra, Dave Bayer

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[Reserved for Score]

Test 1

Name ______________________ Uni ____________

[1] By least squares, find the equation of the form $y = ax + b$ that best fits the data

$$\begin{bmatrix} x_1 & y_1 \\ x_2 & y_2 \\ x_3 & y_3 \\ x_4 & y_4 \end{bmatrix} = \begin{bmatrix} -1 & 1 \\ 0 & 0 \\ 1 & 1 \\ 2 & 1 \end{bmatrix}$$

$y = \square\, x + \square$

F15 Exam 2 Problem 4 [Reserved for Score]

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[4] Find the 4×4 matrix that projects orthogonally onto the plane spanned by the vectors $(1, 0, 1, 0)$ and $(0, 1, 0, 1)$.

$$A = \frac{1}{\square} \begin{bmatrix} \square & \square & \square & \square \\ \square & \square & \square & \square \\ \square & \square & \square & \square \\ \square & \square & \square & \square \end{bmatrix}$$

F16 8:40 Exam 2 Problem 1
Linear Algebra, Dave Bayer

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[Reserved for Score]

Test 1

Name ______________________________ Uni ______________

[1] Find the determinant of the matrix

$$A = \begin{bmatrix} 0 & 1 & 1 & 1 & 1 \\ 0 & 1 & 3 & 3 & 3 \\ 0 & 1 & 1 & 5 & 5 \\ 2 & 2 & 2 & 2 & 2 \\ 0 & 1 & 1 & 1 & 7 \end{bmatrix}$$

$\det(A) =$

test1b2p2

[Reserved for Score]

Test 1

[2] Find the inverse of the matrix

$$A = \begin{bmatrix} 5 & 2 & 1 \\ 3 & 1 & 2 \\ 1 & 1 & 1 \end{bmatrix}$$

$$A^{-1} = \frac{1}{\square} \begin{bmatrix} \square & \square & \square \\ \square & \square & \square \\ \square & \square & \square \end{bmatrix}$$

(Do not write a negative denominator.)

F16 10:10 Exam 2 Problem 3
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test1b2p3

[Reserved for Score]

Test 1

[3] Using Cramer's rule, solve for y in the system of equations

$$\begin{bmatrix} a & 1 & 2 \\ b & 1 & 1 \\ c & 1 & 4 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} 1 \\ 1 \\ 5 \end{bmatrix}$$

$$y = \frac{(\square)\,a + (\square)\,b + (\square)\,c}{(\square)\,a + (\square)\,b + (\square)\,c}$$

test1b2p4

[Reserved for Score]

Test 1

[4] Let $f(n)$ be the determinant of the $n \times n$ matrix in the sequence

$$\begin{bmatrix} 2 \end{bmatrix} \quad \begin{bmatrix} 2 & 5 \\ 1 & 2 \end{bmatrix} \quad \begin{bmatrix} 2 & 5 & 0 \\ 1 & 2 & 5 \\ 0 & 1 & 2 \end{bmatrix} \quad \begin{bmatrix} 2 & 5 & 0 & 0 \\ 1 & 2 & 5 & 0 \\ 0 & 1 & 2 & 5 \\ 0 & 0 & 1 & 2 \end{bmatrix}$$

Find $f(1)$ and $f(2)$. Find a recurrence relation for $f(n)$. Find $f(6)$.

$$f(1) = \square \qquad f(2) = \square$$
$$f(n) = (\square)\, f(n-1) + (\square)\, f(n-2)$$
$$f(6) = \square$$

F15 Exam 2 Problem 2 [Reserved for Score]

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[2] Find the 3×3 matrix A such that

$$A \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix}, \qquad A \begin{bmatrix} 1 \\ -2 \\ 0 \end{bmatrix} = \begin{bmatrix} 1 \\ -2 \\ 0 \end{bmatrix}, \qquad A \begin{bmatrix} 0 \\ 1 \\ -2 \end{bmatrix} = \begin{bmatrix} 0 \\ 1 \\ -2 \end{bmatrix}$$

$$A = \frac{1}{\square} \begin{bmatrix} \square & \square & \square \\ \square & \square & \square \\ \square & \square & \square \end{bmatrix}$$

Test 1

[3] Consider $\mathbb{R}^3$ equipped with the inner product

$$\langle (a,b,c),(d,e,f) \rangle \;=\; \begin{bmatrix} a & b & c \end{bmatrix} \begin{bmatrix} 2 & 1 & 0 \\ 1 & 2 & 1 \\ 0 & 1 & 3 \end{bmatrix} \begin{bmatrix} d \\ e \\ f \end{bmatrix}$$

Using this inner product, find the orthogonal projection of the vector $(3,3,3)$ onto the plane spanned by $(1,0,0)$ and $(0,1,0)$.

$$\begin{bmatrix} \square & \square & \square \end{bmatrix}$$

F17 8:40 Exam 2 Problem 3
Linear Algebra, Dave Bayer

test1a2p3

[Reserved for Score]

Test 1

[3] Consider $\mathbb{R}^3$ equipped with the inner product

$$\langle (a, b, c), (d, e, f) \rangle \;=\; \begin{bmatrix} a & b & c \end{bmatrix} \begin{bmatrix} 1 & 1 & 0 \\ 1 & 2 & 1 \\ 0 & 1 & 2 \end{bmatrix} \begin{bmatrix} d \\ e \\ f \end{bmatrix}$$

Using this inner product, find the orthogonal projection of the vector $(2, 2, 2)$ onto the plane spanned by $(1, 0, 1)$ and $(0, 1, 1)$.

$$\begin{bmatrix} \square & \square & \square \end{bmatrix}$$