Quiz 02 (Set A)

SIAS, Krea University (AY 2025-26)

Mathematical Methods for Economics (Course Code: **ECON211**)

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Multiple Choice Questions

1. (1 point) Identify the element a_{34} in the following matrix A

$$A = \begin{bmatrix} 0 & 1 & 3 & 6 \\ 1 & 2 & 3 & 9 \\ 7 & 5 & 2 & 0 \\ 9 & 4 & 1 & 5 \end{bmatrix}$$

   A. 1

   B. 0

   C. 3

   D. 2

Answer: B

Solution: $a_{34} = 0$.

$$A = \begin{bmatrix} a_{11} = 0 & a_{12} = 1 & a_{13} = 3 & a_{14} = 6 \\ a_{21} = 1 & a_{22} = 2 & a_{23} = 3 & a_{24} = 9 \\ a_{31} = 7 & a_{32} = 5 & a_{33} = 2 & \boxed{a_{34} = 0} \\ a_{41} = 9 & a_{42} = 4 & a_{43} = 1 & a_{44} = 5 \end{bmatrix}$$

2. (1 point) Find the roots of the following quadratic equation: $-2x^2 + 40x - 600 = 0$.

   A. $(10, -40)$

   B. $(10 \pm \sqrt{5})$

   C. No real roots exist

   D. $(-10, 30)$

Answer: C

Solution: We will first compute the discriminant to check if the equation has any (real) roots. $a = -2$, $b = 40$, and $c = -600$.

$$\begin{aligned} & b^2 - 4ac = (40)^2 - (4 \times (-2)(-600)) && \text{(using given values)} \\ \implies & b^2 - 4ac = 1600 - 4 \times (2 \times 600) && \text{(since } (-a) \times (-b) = ab\text{)} \\ \implies & b^2 - 4ac = 1600 - 4 \times 1200 \\ \implies & b^2 - 4ac = 1600 - 4800 \\ \implies & b^2 - 4ac < 0 \end{aligned}$$

The equation, therefore, has no real roots.

3. (1 point) Consider the following statements:

Statement (i): The set of equations: $\boxed{2x + 3y = 5 \text{ and } 4x + 6y = 7}$ does not have any solution.

Statement (ii): The set of equations: $\boxed{4x - y = 3 \text{ and } -28x + 7y = 21}$ does not have any solution.

   A. Both (i) and (ii) are correct.

   B. Statement (i) is correct but statement (ii) is incorrect.

   C. Statement (ii) is correct but statement (i) is incorrect.

   D. Both statements are incorrect.

Answer: A

Solution: Consider the first equation from Statement (i).

$$\begin{aligned} & 2x + 3y = 5 \\ \implies & 2 \times (2x + 3y) = 2 \times 5 && \text{(multiplying both sides by 2.)} \\ \implies & 4x + 6y = 10 \end{aligned}$$

This is incompatible with $4x + 6y = 7$. Therefore, this set doesn't have a solution. So, the assertion is indeed right.

Consider the second equation from Statement (ii).

$$\begin{aligned} & -28x + 7y = 21 \\ \implies & 4x - y = -3 && \text{(dividing both sides by -3)} \end{aligned}$$

This is incompatible with $4x - y = -3$. Therefore, this set, too, doesn't have any solution. So, this assertion is also correct.

Short Answer Questions-I

4. (1 point) Let $A = \begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}$ and $B = \begin{bmatrix} 0 & -1 \\ 6 & 7 \end{bmatrix}$. Compute AB.

Solution: Let

$$C = AB = \begin{bmatrix} c_{11} & c_{12} \\ c_{21} & c_{22} \end{bmatrix}$$

$$\begin{aligned} c_{11} &= (1 \times 0) + (2 \times 6) = 12 \\ c_{12} &= (1 \times -1) + (2 \times 7) = 13 \\ c_{21} &= (3 \times 0) + (4 \times 6) = 24 \\ c_{22} &= (3 \times -1) + (4 \times 7) = 25 \end{aligned}$$

Answer:

$$AB = \begin{bmatrix} 12 & 13 \\ 24 & 25 \end{bmatrix}$$

5. (1 point) There are two matrices A and B such that:

$$A = \begin{bmatrix} x+5 & 0 & 3 \\ 4 & 0.75y & 8 \end{bmatrix}, \quad B = \begin{bmatrix} 6 & 5 & 0.5 \\ 10 & 2 & -10 \end{bmatrix}, \quad 2A + B = \begin{bmatrix} 24 & 5 & 6.5 \\ 18 & 5 & 6 \end{bmatrix}$$

Compute x and y.

Solution: Using equality of matrices, we can write:

$$\begin{aligned} & 2(x+5) + 6 = 24 \\ \implies & 2(x+5) = 18 \\ \implies & x + 5 = 9 \\ \implies & x = 9 - 5 \\ \implies & x = 4 \end{aligned}$$

$$\begin{aligned} & 2(0.75y) + 2 = 5 \\ \implies & \frac{6}{4}y = 3 \\ \implies & 6y = 12 \\ \implies & y = 2 \end{aligned}$$

Answer: $\boxed{x = 4}$, $\boxed{y = 2}$

6. (1 point) Solve for x and y:

$$\begin{aligned} 4x - 3y &= 1 \\ 2x + 9y &= 4 \end{aligned}$$

Solution:

$$
\begin{aligned}
12x - 9y &= 3 && \text{(multiplying the first equation by 3)} \\
2x + 9y &= 4 \\
\implies 14x &= 7 && \text{(adding the two equations)} \\
\implies x &= \frac{1}{2} \\
4(\frac{1}{2}) - 3y &= 1 && \text{(plug the value of x in the first equation)} \\
\implies 2 - 3y &= 1 \\
\implies 3y &= 1 && \text{(rearranging terms)} \\
\implies y &= \frac{1}{3}
\end{aligned}
$$

Answer: $\boxed{x = \frac{1}{2}}$, $\boxed{y = \frac{1}{3}}$.

Short Answer Questions-II

7. (2 points) Given the following supply and demand equations:

$$
\text{Supply: } P = 2Q_S^2 + 10Q_S + 10
$$
$$
\text{Demand: } P = -Q_D^2 - 5Q_D + 52
$$

Calculate the equilibrium price and quantity.

Solution: We know that, at equilibrium, the following is true:

$$
\begin{aligned}
\text{Supply} &= \text{Demand} \\
Q_S &= Q_D = Q
\end{aligned}
$$

Therefore,

$$
\begin{aligned}
2Q^2 + 10Q + 10 &= -Q^2 - 5Q + 52 \\
\implies 3Q^2 + 15Q - 42 &= 0 && \text{(rerranging terms)} \\
\implies Q^2 + 5Q - 14 &= 0 && \text{(dividing both sides by 3)} \\
\implies Q^2 + 7Q - 2Q - 14 &= 0 && \text{(since } 5Q = 7Q - 2Q\text{)} \\
\implies Q(Q+7) - 2(Q+7) &= 0 \\
\implies (Q+7)(Q-2) &= 0 && \text{(since } a(b+k) - c(b+k) = (a-c)(b+k)\text{)} \\
\implies Q^* &= 2 && \text{(since quantities cannot be negative)} \\
P^* &= 2(Q^*)^2 + 10Q^* + 10 && \text{(using the supply equation)} \\
\implies P^* &= 2(2)^2 + 10 \times 2 + 10 && \text{(since } Q^* = 2\text{)} \\
\implies P^* &= 38
\end{aligned}
$$

Answer: $\boxed{Q^* = 2}$, $\boxed{P^* = 38}$

8. (2 points) Use Cramer's rule **OR** matrix inverse method to solve the following set of equations:

$$
\begin{aligned}
5x_1 + 9x_2 &= 14 \\
7x_1 - 3x_2 &= 4
\end{aligned}
$$

Solution: Cramer's Rule

First, write all the matrices you need.

$$
A = \begin{bmatrix} 5 & 9 \\ 7 & -3 \end{bmatrix}, \quad B = \begin{bmatrix} 14 \\ 4 \end{bmatrix}, \quad X = \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}
$$

We also need D_{x_1} and D_{x_2}.

$$D_{x_1} = \begin{vmatrix} 14 & 9 \\ 4 & -3 \end{vmatrix}$$
$$D_{x_2} = \begin{vmatrix} 5 & 14 \\ 7 & 4 \end{vmatrix}$$
$$|A| = \begin{vmatrix} 5 & 9 \\ 7 & -3 \end{vmatrix} = -78$$

Therefore,

$$x_1 = \frac{D_{x_1}}{|A|}$$
$$x_2 = \frac{D_{x_2}}{|A|}$$
$$D_{x_1} = -78$$
$$D_{x_2} = -78$$
$$\implies x_1 = 1, \quad x_2 = 1$$

Matrix Inverse Method

We know that $X = A^{-1}B$ and $A^{-1} = \dfrac{adj(A)}{|A|}$.

$$A^{-1} = \frac{1}{-78}\begin{bmatrix} -3 & -9 \\ -7 & 5 \end{bmatrix} \implies A^{-1}B = \frac{1}{78}\begin{bmatrix} -3 & -9 \\ -7 & 5 \end{bmatrix} \times \begin{bmatrix} 14 \\ 4 \end{bmatrix}$$
$$\implies A^{-1}B = \frac{1}{-78}\begin{bmatrix} (-3 \times 14) + (-9 \times 4) \\ (-7 \times 14) + (5 \times 4) \end{bmatrix}$$
$$\implies A^{-1}B = \frac{1}{-78}\begin{bmatrix} -78 \\ -78 \end{bmatrix}$$
$$\implies A^{-1}B = \begin{bmatrix} 1 \\ 1 \end{bmatrix}$$
$$\implies X = \begin{bmatrix} 1 \\ 1 \end{bmatrix}$$

Answer: $\boxed{x_1 = 1}$, $\boxed{x_2 = 1}$.