L.A PRACTICAL

(MCQ)

CH 1 : LINEAR EQUATIONS and MATRICES

Example of linear equation involving two variables is

a) 7x+3y+4z = 20
b) 6x+2y = 10
c) 8x = 2+10
d) 7a+8b+9c = 10+5

In linear equation 'ax+by = c' a , b and c are considered as

a) variable
b) constants
c) zero
d) real numbers

Number of ordered pair values (x,y) to satisfy linear equation ax + by = c are

a) finite
b) infinite
c) zero
d) rational expression

Two equations that have no values to satisfy both equations then this is called no solution

a) consistent system
b) inconsistent system
c) solution system
d) constant system

Method in which both sides of equation are multiplied by nonzero constant is classified as

a) Gaussian elimination method
b) Gaussian inconsistent procedure
c) Gaussian consistent procedure
d) Gaussian substitute procedure

In Gaussian elimination method, original equations are transformed by using

a) column operations
b) row operations
c) mathematical operations
d) subset operations

In three dimensional coordinate systems, coordinates are

a) perpendicular to each other
b) parallel to each other
c) same direction for each other
d) opposite direction for each other

For solution set, set builder notation is S =

a) {(a,b,c) | ax+by = c}
b) {(x,y,a) | abx+bcy = c}
c) {(a,b,x,y) | ax+ bc = yc}
d) {(x,y) | ax+by = c}

What form do you need to change your matrix into when using Gauss-Jordan elimination?

- row echelon form
- augmented form
- reduced row echelon form
- regular form
- none

What is the first row of our augmented matrix? $\left\{\begin{array}{l} x+z=3 \\ y=4 \\ 2z=6 \end{array}\right.$

$$\left[\begin{array}{ccc|c} 1 & 0 & 1 & 3 \\ 0 & 1 & 0 & 4 \\ 0 & 0 & 2 & 6 \end{array}\right]$$

- 0, 0, 2, and 6
- 0, 1, 0, and 4
- 1, 1, 1, and 3
- 1, 0, 1, and 3
- 0, 2, 0, 4

If a matrix is in reduced row echelon form, then it is also in row echelon form:

a) False
b) True
c) May be
d) None of the above

A homogeneous linear system always has the trivial solution, there are only two possibilities for its solutions:

a) The system has only the trivial solution.
b) The system has infinitely many solutions in addition to the trivial solution.
c) Both (a) and (b)
d) None of the above

A system of linear equations is said to be homogeneous if the constant terms are all:

e) One
f) Zero
g) Both (a) and (b)
h) None of the above $\times 2$

The system of equations 4x + 6y = 5, 8x + 12y = 10 has:

a) No solution.
b) Infinitely many solutions.
c) A unique solution.
d) None of the above

$x = A^{-1}b$

If Ax = b is a system of n linear equations in n unknowns such that det (A)≠ 0, then the system has:

a) Infinitely many solutions.
b) Unique solution.
c) Both (a) and (b).
d) None of the above

MCQ: A pair of equations to determine value of 2 variables is called

a) simultaneous linear equations
b) paired equations
c) quadratic equations
d) simple equations

MCQ: Methods to solve a pair of simultaneous linear equations are

a) 3
b) 2
c) 4
d) 5

In Gaussian reduction procedure, matrix A is augmented with an identity (m x m) as:

a) (A | N)
b) (A | I)
c) (A | B)
d) None of the above A

After performing row operations on augmented matrix A in Gaussian reduction procedure then resulting matrix is:

a) $(B^{-1} | I)$
b) $(I | A^{-1})$
c) $(M | B^{-1})$
d) d)None of the above

Reduced echelon form of the matrix $\begin{matrix} 1 & 2 & 3 \\ 2 & 3 & 4 \end{matrix}$ **is:**

a) $\begin{matrix} 1 & 2 & 3 \\ 0 & 0 & 1 \end{matrix}$

b) $\begin{matrix} 1 & 0 & -1 \\ 0 & 1 & 2 \end{matrix}$

c) $\begin{matrix} 1 & 0 & 0 \\ 0 & 1 & 1 \end{matrix}$

$\begin{matrix} 1 & 2 & 3 \\ 0 & -1 & -2 \end{matrix} \rightarrow \begin{matrix} 1 & 0 & -1 \\ 0 & +1 & +2 \end{matrix}$

A set of linear equations is represented by the matrix equation Ax=b. The necessary condition for the existence of a solution for this system is

a) A must be invertible

b) b must be linearly depended on the columns of A

c) b must be linearly independent of the columns of A

d) None of these

MCQ: If a matrix has equal number of columns and rows then it is said to be a

A. row matrix
B. identical matrix
C. square matrix
D. rectangular matrix

MCQ: If determinant of a matrix is equal to zero, then it is said to be

A. square matrix
B. singular matrix non invertable
C. non-singular matrix
D. identical matrix

MCQ: If number of columns and rows are not equal in a matrix, then it is said to be a

A. rectangular matrix
B. square matrix
C. diagonal matrix
D. null matrix

MCQ: Skew symmetric matrix is also called

A. symmetric
B. identical matrix
C. square matrix
D. anti symmetric

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

MCQ: A diagonal matrix having equal elements is called a

A. square matrix
B. identical matrix
C. scalar matrix
D. rectangular matrix

MCQ: A Matrix with only 1 column is called

A. unit or identical matrix
A. column matrix
B. row matrix
C. identical matrix

MCQ: If all elements in a matrix are zeros, then it is called a

A. column matrix
B. diagonal matrix
C. identical matrix
D. null/zero matrix

MCQ: A matrix with only 1 row is called

A. column matrix
B. row matrix
C. identical matrix
D. square matrix

MCQ: If two matrices A and B have same order and their corresponding elements are equal then it is called

A. matrix equality
B. rectangular matrix
C. square matrix
D. identical matrix

ملاحظات : * في حالة انطباق خطين , السيستم بيكون ليه عدد لا نهائي من الحلول
* في حالة التقاطع , السيستم ليه حل واحد
* في حالة التوازي , السيستم ليس له حل

* system that has infinity or unique solution ,, is called consistent.
*system that has no solution ,, is called inconsistent.

CH 2: MATRICES ARITHMETIC

MCQ: If A and B matrices are of same order and A + B = B + A, this law is known as

A. distributive law
B. commutative law
C. associative law
D. cramer's law

MCQ: If sum of two matrices A and B is zero matrix, then A and B are said to be

A. multiplicative inverse of each other
B. additive inverse of each other
C. transpose of each other
D. determinant of each other

MCQ: Law which does not hold in multiplication of matrices is known as

A. distributive law
B. Inverse law
C. associative law
D. commutative law

MCQ: If A, B and C matrices are of same order and (A + B) + C = A + (B + C), this law is known as

A. cramer's law
B. distributive law
C. commutative law
D. associative law

MCQ: We can add or subtract two matrices having real numbers A and B if their

A. order is same
B. rows are same
C. columns are same
D. elements are same

$$\begin{bmatrix} 10 & -6 \\ 12 & 0 \end{bmatrix} + \begin{bmatrix} -6 & 2 \\ -5 & 3 \end{bmatrix}$$

is equal to which matrix?

a) $\begin{bmatrix} -4 & 21 \\ 9 & 4 \end{bmatrix}$

b) $\begin{bmatrix} 4 & -4 \\ 7 & 3 \end{bmatrix}$

c) $\begin{bmatrix} 4 & -12 \\ 12 & -5 \end{bmatrix}$

d) $\begin{bmatrix} 16 & -8 \\ 17 & -3 \end{bmatrix}$

Q= $\begin{bmatrix} 2 & 1 \\ -1 & 1 \\ 3 & 4 \end{bmatrix}$ **R=** $\begin{bmatrix} -7 & 3 \\ -4 & 1 \\ 3 & -2 \end{bmatrix}$

Q – R =

A. $\begin{bmatrix} 2 & 9 \\ 0 & 3 \\ 6 & 9 \end{bmatrix}$ C. $\begin{bmatrix} -5 & 2 \\ -5 & 0 \\ -9 & -6 \end{bmatrix}$

B. $\begin{bmatrix} 9 & -2 \\ 3 & 0 \\ 0 & 6 \end{bmatrix}$ D. $\begin{bmatrix} 7 \\ 3 \\ -11 \end{bmatrix}$

I_3 $(I_3)^{-1}$

9. Let I3 be the Identity matrix of order 3 then (I3)-1 is equal to:

a) 0

b) $3I_3$

c) I_3

d) None of the mentioned.

The multiplication of the matrices $\begin{bmatrix} 3 & 2 & 1 \\ 1 & 5 & 0 \\ 2 & 2 & 1 \end{bmatrix}$ and $\begin{bmatrix} 1 \\ 3 \\ 5 \end{bmatrix}$ **gives a**

- *3 x1 matrix.*
- *1 x 3 matrix.*
- *1 x 1 matrix.*
- *3 x 3 matrix.*

When you multiply a matrix by the identity matrix, you obtain the

- *inverse matrix.*
- *the transpose matrix.*
- *adjoint matrix.*
- *cofactor matrix.*
- *original matrix.*

Multiply matrix $\begin{bmatrix} 5 & 3 \\ -3 & -2 \end{bmatrix}$ by $\begin{bmatrix} -4 \\ 3 \end{bmatrix}$

- $\begin{bmatrix} -11 & 6 \end{bmatrix}$
- $\begin{bmatrix} 11 \\ -6 \end{bmatrix}$
- $\begin{bmatrix} -6 & 11 \end{bmatrix}$
- $\begin{bmatrix} -11 \\ 6 \end{bmatrix}$
- *none of the above*

$\begin{bmatrix} -20+9 \\ 12-6 \end{bmatrix}$

MCQ: If A is a matrix of order(m*n) then a matrix(n*m) obtained by interchanging rows and columns of A is called the

A. additive inverse of A

B. transpose of A

C. determinant of A

D. order of A

$B = A^T$

The matrix B = AT, where A is any matrix is

a) skew symmetric
b) symmetric about the secondary diagonal
c) always symmetric
d) not symmetric

MCQ: In matrices $(A + B)^t$ equals to

A. A^t
B. B^t
C. $A^t + B^t$
D. $A^t B^t$

MCQ: In matrices $(AB)^t$ equals to

a) A^t
b) B^t
c) $B^t A^t$
d) $A^t B^t$

If A and B be real symmetric matrices of size n x n, then

a) $AA^T = 1$
b) $A = A^{-1}$
c) $AB = BA$
d) $A= A^t$

E) $(AB)^T = BA$

For a matrix A, B and identity matrix I, if a matrix AB=I=BA then:

a) B is inverse of A
b) A is inverse of B
c) $A^{-1} = B$, $B^{-1} = A$
d) All of the mentioned

MCQ: In matrices $(AB)^{-1}$ equals to

a) A^{-1}
b) $B^{-1} A^{-1}$
c) $A^{-1} B^{-1}$
d) B^{-1}

Cramer's rule leads easily to a general formula for:

a) The adjugate of a matrix A.
b) The determinant of a matrix A.
c) The inverse of n x n matrix A.
d) None of the above

If A is an invertible square matrix then:

a) $(A^T)^{-1} = (A^{-1})^T$
b) $(A^T)^T = (A^{-1})^T$
c) $(A^T)^{-1} = (A^{-1})^{-1}$
d) None of the mentioned

The inverse of the matrix $\begin{bmatrix} 5 & 3 \\ 10 & 6 \end{bmatrix}$ **is**

- $\begin{bmatrix} .2 & .33 \\ .1 & .167 \end{bmatrix}$
- $\begin{bmatrix} .5 & .3 \\ 1.0 & .6 \end{bmatrix}$
- $\begin{bmatrix} .167 & .1 \\ .33 & .2 \end{bmatrix}$
- *undefined*.
- *none of the above*

30 − 30

If A, B, C are square matrices of the same order, then $(ABC)^{-1}$ is equal to

a) $C^{1}A^{-1}B^{-1}$

b) $C^{-1} B^{-1} A^{-1}$

c) $A^{-1} B^{-1}C^{-1}$

d) $A^{-1} C^{-1} B^{1}$

NOTES :

- $(A^T)^T = A$
- $(kA)^T = kA^T$
- $(AB)^T = B^T A^T$
- $(A+B)^T = A^T + B^T$
- If A is nonsingular, then so is A^{-1} and $(A^{-1})^{-1} = A$
- If A and B are nonsingular **matrices**, then AB is nonsingular and. $(AB)^{-1} = B^{-1}A^{-1}$
- **i**f A is nonsingular then $(A^T)^{-1} = (A^{-1})^T$
- **i**f A and B are matrices with $AB = I_n$ then A and B are inverses of each other.
- A is nonsingular
- $Ax = 0$ has only the trivial solution
- A is row equivalent to I
- The linear system $Ax = b$ has a unique solution for every nx1 matrix b.
- When the matrix is invertible , it's inverse is given by the formula:

$$A^{-1} = \frac{1}{ad-bc(det)} \begin{vmatrix} d & -b \\ -c & a \end{vmatrix}$$

CH 3: DETERMINANTS

MCQ: Value of determinant is computed by adding multiples of one row to

A. another dimension
B. another row
C. another column
D. another matrix

In computation of determinant of a matrix, significant efficiencies are introduced by combining row to another which

A. contains subtraction
B. contains zero
C. contains ones
D. contains addition

According to determinant properties, when two rows are interchanged then signs of determinant

A. must changes
B. remains same
C. multiplied
D. divided

According to determinant properties, determinant equals to zero if row is

A. multiplied to row
B. multiplied to column
C. divided to row
D. divided to column

AccorDing to determinant properties, determinant of resulting matrix equals to k delta if elements of rows are

A. multiplied to constant k
B. added to constant k
C. multiplied to constant k
D. divided to constant

MCQ: If determinant of a matrix is not equal to zero, then it is said to be

A. non-singular matrix
B. square matrix
C. singular matrix
D. identical matrix

The value of the determinant $\begin{vmatrix} d & b \\ c & a \end{vmatrix}$ **is**

- db - ca.
- da - cb.
- dc + ba.
- db + ca.
- dc - ba.

The correct determinant value for the determinant $\begin{vmatrix} 7 & 8 \\ 5 & 2 \end{vmatrix}$ **would be**

- *(7)(5) - (8)(2).*
- *(7)(2) + (5)(8).*
- *(7)(8) - (5)(2).*
- *(7)(2)(5)(8).*
- *(7)(2) - (5)(8).*

Let A be a square matrix of order 3 x 3 with det (A)= 21, then det (2A) is:

a) 168
b) 186
c) 126
d) None of the above.

$2^3 \times 21 = 168$

If A and B are square matrices of size n x n, then which of the following statement is not true?

a) det. (AB) = det (A) det (B)

b) det (kA) = k^n det (A)

c) det (A + B) = det (A) + det (B)

d) det (A^T) =1/det (A^{-1})

$(\text{cofactors})^T$

State True or False:
For a matrix A of order n, the det (adj (A)) = (det(A))n , where adj() is adjoint of matrix

a) True
b) False

Rule which provides method of solving determinants is classified as:

a) Cramer's rule.
b) Determinant rule.
c) Solving rule.
d) None of the above

$$A = \begin{matrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{matrix}$$

$$M_{11} = \begin{vmatrix} 5 & 6 \\ 8 & 9 \end{vmatrix} = (5)(9)-(8)(6)=-3$$

Cij = $(-\mathbf{1})^{i+j}$ **+ *Mij***

$C_{11} = (-\mathbf{1})^{\mathbf{1+1}}$ **+ (-3) = -2**

NOTES :

$\begin{bmatrix} 1 & 2 & 4 \\ 0 & 0 & 3 \\ 0 & 0 & 2 \end{bmatrix}$

- The adjoint of a matrix A is the transpose of the cofactor matrix. It is denoted by adj A . An adjoint matrix is also called an adjugate matrix.

$\begin{bmatrix} 1 & 0 & 0 \\ 1 & 3 & 0 \\ 1 & 2 & 1 \end{bmatrix}$

- The **determinant** of a **lower triangular matrix** (or an **upper triangular matrix**) and diagonal matrix is the product of the diagonal entries.

$\begin{bmatrix} 1 & 0 & 0 \\ 0 & 2 & 0 \\ 0 & 0 & 3 \end{bmatrix}$

- the **determinant** of A is equal to zero then A is not invertible.

not

singular

CH 4: VECTORS

The two vectors are said to be equivalent if:

a) Same length.

b) Same direction.

c) Both (a) and (b).

d) None of the above.

If one of the vectors is a scalar multiple of the other, then the vectors lie on a common line, so such vectors are:

a) Parallel.
b) Collinear.
c) Perpendicular.
d) None of the above

Unit vectors are normally used to represent other vector's

a) direction
b) place
c) velocity
d) magnitude

The Norm of the vector v= −3, 2, 1 is:

a) 14.
b) 7.
c) $\sqrt{14}$
d) None of the above.

A vector of norm 1 is called a:

e) Unit vector.
f) Parallel vector.
g) Zero vectors.
h) None of the above.

a b

The two vectors (-2,1) and (1,2) are…

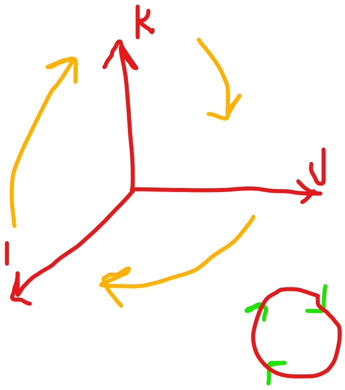
$$\cos\theta = \frac{|a \cdot b|}{\|a\|\|b\|}$$

a) linearly dependent of each other
b) forming an orthonormal basis
c) perpendicular to each other
d) pointing in the opposite direction of each other

Commutative law is valid for the cross product of two vectors. (Commutative law: PxQ = QxP; for two vectors P and Q)

a) True

b) False



Which of the following is true?

a) i x i =1

b) j x i = -j

c) k x j = -i

d) k x k = 1

Which of them is not correct?

a) j x j = 0

b) j x k = i

c) j x i = k → -k

d) j x i = -k

x zero

1 0 -1 0

What is {(i.i) + (-i.j) + (-k.k) + (k.i)}.(Ai +Bj + Cz)?

a) 1

b) 0

c) A + B + C

d) -1

x → i → (1, 0, 0)

y → j → (0, 1, 0)

z → k → (0, 0, 1)

The scalar product (aka dot product) of two perpendicular vectors is

a) 0

b) 1

c) 2 PI

d) -2 PI

e) none of the above.

If the angle between two vectors (both having a non-zero magnitude) is greater than 90° and smaller than 270°, then the scalar product (dot product) of these vectors is…

a) positive

b) negative

c) undefined

d) positive when the angle is smaller than 180°, negative when the angle is greater than 180°

If the scalar product (dot product) of two unit vectors is zero, they are…

a) linearly dependent
b) forming an orthonormal basis
c) pointing in the same direction
d) at an angle of 180 degrees to each other.

The process of multiplying a nonzero vector by the reciprocal of its length to obtain a unit vector is called:

a) Triangular vector.
b) Normalizing.
c) Cramer's rule.
d) None of the above.

If u = 1, 3, − 2, 7 and v = 0, 7, 2, 2 are two vectors then the distance between u and v is:

a) 28.
b) 12.
c) $\sqrt{58}$
d) None of the above.

For two vectors A and B, what is A.B (if they have angle α between them)?

a) |A||B| cosα
b) |A||B|
c) √(|A||B|) cosα
d) |A||B| sinα

Mathematically, for two vectors A and B of any magnitude, the cross product of both, i.e. AxB = given by:

a) $|A||B|\sin\theta$
b) |A||B|
c) $|A||B|\cos\theta$
d) $|A||B|\sin(180°+\theta)$

What is the Euclidean length $||\vec{v}||$ of vector $\vec{v} = (0,3,4,0)$?

Answer: $||\vec{v}|| = \sqrt{0^2 + 3^2 + 4^2 + 0^2} = \sqrt{25} = 5$

What is the scalar product (or dot product) $\vec{v} \cdot \vec{w}$ of the two vectors $\vec{v} = (0 , 5 , -2)$ and $\vec{w} = (3 , 1 , -2)$?

Answer: $\vec{v} \cdot \vec{w}$ = (0*3) + (5*1) + (-2 * -2) = 9

What is the cross product $\vec{v} \times \vec{w}$ of the two vectors $\vec{v} = (0 , 5 , -2)$ and $\vec{w} = (3 , 1 , -2)$?

$$\begin{vmatrix} 0 & 5 & -2 \\ 3 & 1 & -2 \end{vmatrix}$$

Answer: $\vec{v} \times \vec{w} = (-8, -6, -15)$

$(-10+2, -(0+6), (0-15))$

Projection of vector A in direction of x-axis is represented by angle of

$Proj_x A = \frac{A \cdot x}{1}(1,0,0)$ $\quad \|A\| \|x\| \cos(\theta)$

$\|x\|^2 \quad \vec{x}$

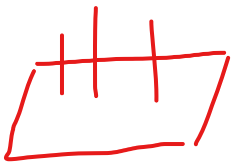
a) Cos
b) Sin
c) Tan
d) both a and b

Orthographic projection represents three dimensional objects in

a. One dimension
b. Two dimension
c. Three dimension
d. All of the above

In orthographic projection, the projection lines are _______ to the projection plane.

a. Parallel
b. Orthogonal
c. Inclined
d. Any of the above



The point, from which the observer is assumed to view the object, is called

a. Center of projection
b. Point of projection
c. Point of observer
d. View point

NOTES :

- A scalar is a physical quantity with magnitude only.
- A vector is a physical quantity with magnitude and direction.
- Two vectors are equal if they have the **same** magnitude and the **same** direction
- A negative vector is a vector that has the *opposite* direction to the reference positive direction.
- The resultant vector is the single vector whose effect is the same as the individual vectors acting together.
- The equilibrant is the vector which has the *same magnitude* but *opposite direction* to the resultant vector.

COLLECTION OF LAWS

U=(u1,u2,u3)   V=(v1,v2,v3)

- V.U = ||u|| ||v|| cosθ.
- cos θ = $\frac{u.v}{||u||\,||v||}$
  - U.V > 0 → cosθ > θ → $0 \le \theta < \frac{\pi}{2}$ acute
  - U.V < 0 → cosθ < θ → $\frac{\pi}{2} < \theta \le \pi$ obtuse
  - U.V = 0 → cosθ = θ → $\theta = \frac{\pi}{2}$ → u ⊥ v

- ||U|| = $\sqrt{u_1^2 + u_2^2 + u_3^2}$

- U.U = $(||u||)^2 = u^2$

- $proj_a^u = \frac{u.a}{||a||^2}$. a
  - $||proj_a^u||$ =|| $\frac{u.a}{||a||^2}$. a|| = $\frac{|u.a|}{||a||}$

- ||KU||= |k| ||u||

- D (u , v) = ||u-v||
- D (u , v) = D(v , u)
- D (u , v) ≤ D(u , w) + D(w , v)

- U X V = ($\begin{vmatrix} u2 & u3 \\ v2 & v3 \end{vmatrix}$, $\begin{vmatrix} u1 & u3 \\ v1 & v3 \end{vmatrix}$, $\begin{vmatrix} u1 & u2 \\ v1 & v2 \end{vmatrix}$)

  = (u2v3 – v2u3 , u1v3 – v1u3 , u1v2 – v1u2).

U = ($u_1 i$, $u_2 j$, $u_3 k$)

- U X V = $\begin{vmatrix} i & j & k \\ u1 & u2 & u3 \\ v1 & v2 & v3 \end{vmatrix}$ → i , j, k (متجهات الوحده القياسيه)

- $||U\ X\ V||^2 = ||u||^2\ ||v||^2 - (u.v)^2$
- U X V = - (V X U)

- $U.(U\ X\ V)$ → u ⊥ (u x v)

- $V.(U \; X \; V) \;\rightarrow$ v ⊥ (u x v)
- $U \; X \; U = 0$ (المتجه الصفري)
- U X (V X W) = (U . W)V – (U . V)W
- (U X V) X W = (U . W) V– (V . W)U

- $||U+V||^2 = ||u||^2 + ||v||^2$ + 2 ||u|| ||v|| cosθ
- $||U-V||^2 = ||u||^2 + ||v||^2$ - 2 ||u|| ||v|| cosθ
- $||U+V||^2 = ||U-V||^2 \;\rightarrow$ u ⊥ v

- $||U \; X \; V||$ = area of parallelogram which determined by u , v

- $U.(V \; X \; W) = \begin{vmatrix} u1 & u2 & u3 \\ v1 & v2 & v3 \\ w1 & w2 & w3 \end{vmatrix} = 0 \;\rightarrow$ u,w,v يقعوا في نفس المستوى

- Ax + By + Cz = 0 (معادلة المستوى)
  - a(x-x_0) + b(y-y_0) + c(z-z_0) = 0

- $P_0 = (x_0 , y_0 , z_0)$, Ax + By + C = 0
  - $D = \frac{|\, a_{x0} + b_{y0} + c \,|}{\sqrt{a^2+b^2}}$

- $P_0 = (x_0 , y_0 , z_0)$, Ax + By + Cz + d = 0
  - $D = \frac{|\, a_{x0} + b_{y0} + c_{z0} + d \,|}{\sqrt{a^2+b^2+c^2}}$

- U || V $\rightarrow$ u = ku

- a1 x + b1 y + c1 z + d1 = 0 n1 = (a1 , b1 , c1)
- a2 x + b2 y + c2 z + d2 = 0 n2 = (a2 , b2 , c2)
  - n1 || n2 $\rightarrow$ n1 = kn2 $\rightarrow \frac{a1}{a2} = \frac{b1}{b2} = \frac{c1}{c2} = k$
  - n1 ⊥ n2 $\rightarrow$ n1 . n2 = 0 $\rightarrow$ a1a2 + b1b2 + c1c2 = 0