Gajendra Purohit

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VECTOR SPACE

Field : A non-empty commutative set $(F, +, .)$ is a field if every non-zero element of F has multiplicative inverse.

Note : If $(F, +, .)$ is field then $(F, +)$ and $(F^*, .)$ are abelian group.

Note :

(1) Z_p is a field iff p is prime.

(2) Cardinality of field never divisible by two distinct prime number.

i.e. if F is field then $|F| = p^n$; p is prime.

Internal composition : If A be any set s.t. $a * b \in A$, where $a \in A$, $b \in A$ then $*$ is said to be internal composition in the set A.

External composition : Let V & F be any two set.

If $a * \alpha \in V$,where $a \in V$, $\alpha \in F$ then '*' is said to be

external composition in V over F.

Vector Space : Let (F, +, .) be a field & V be non-empty set. The elements of F are called scalars & the elements of V are called vectors. Then V is a vector space over the field if –

(i) (V, +) is abelian group.

(ii) V is closed with respect to scalar multiplication $\alpha u \in V$, for all $\alpha \in F, u \in V$

(iii) Scalar multiplication and vectors addition

(a) $\alpha(u + v) = \alpha u + \alpha v$, for all $\alpha \in F$, for all $u, v \in V$

(b) $(\alpha + \beta)u = \alpha u + \beta u$, for all $\alpha, \beta \in F$, for all $u \in V$

(c) $(\alpha\beta)u = \alpha(\beta u)$; for all $\alpha, \beta \in F$, for all $u \in V$

(iv) $1.u = u$; for all $u \in V$, where 1 is the unit element of the field F.

Matrix Vector space :

Let $V = \{[a_{ij}]_{m\times n}; a_{ij} \in P\}$ and F = Q

then V is vector space over F if Q is subset of P

Polynomial Vector space :

Sequence Vector Space :

Let $V = \{<x_n> \mid x_n \in R\}$ and $F = R$

s.t. $<x_n> + <y_n> = <x_n + y_n>$ and $\alpha <x_n> = <\alpha x_n>$

Function Space :

Let $V = \{f \mid f : X \to R\}$ & $F = (R, +, .)$

Subspace : Let V(F) be a vector space. Let W be any non-empty subset of V, then W is called subspace of V over F if W itself a vector space with the same field and same composition.

Note :

(1) $\{0\}$ and V itself are always subspace of V.

(2) Any subspace other than $\{0\}$ and V known as proper subspace of V.

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Test for subspace : A necessary and sufficient condition for subspace.

(1) Two step test :

(a) $x + y \in W$ for all $x \in W$, for all $y \in W$

(b) $\alpha x \in W$ for all $\alpha \in F$, $x \in W$

(2) One step test :

$\alpha x + \beta y \in W$; for all $\alpha, \beta \in F$ & for all $x, y \in W$

Subspace in R : The only subspace in R are $\{0\}$ & (R)

Subspace in R^2 :There are three subspace in R^2.

(i) $W_1 = \{(0, 0)\}$

(ii) $W_2 = R^2$

(iii) Any line passing through an origin is also a subspace of R^2.

Subspace in R^3

There are four subspace in R^3

(i) $W = \{(0, 0, 0)\}$

(ii) $W = R^3$

(iii) Any plane passing through an origin

(iv) Any line passing through an origin

Vector Matrix Space :

Matrix space : Let $V = \{A = [a_{ij}]_{n\times n};\ a_{ij} \in R\}$ & $F = R$

Polynomial space :

Q.1. Which one of the following sets of vectors $\alpha = (a_1, a_2, ..., a_n)$ in R^n is a subspace of $R^{n(n\geq3)}$?

(a) all α such that $a_1 \geq 0$

(b) all α such that $a_1 + 3a_2 = a_3$

(c) all α such that $a_2 = a_1^2$

(d) all α such that $a_1a_2 = 0$

Q.2. Which of the following subsets are subspace?

(a) $W = \{(x, y) \in R^2; xy = 0\}$

(b) $X = \{(x, y) \in R^2; y = 3x\}$

(c) $Y = \{(x, y) \in R^2; x^2 - y^2 = 0\}$

(d) $Z = \{(x, y) \in R^2; x^2 + y^2 = 0\}$


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Q.3 Which one of the following is a subspace of R^3?

(a) $(x, y, z) \in R^3 \mid x + 2y = 0, 2x + 3z = 0\}$

(b) $\{(x, y, z) \in R^3 \mid 2x + 3y + 4z - 3 = 0, z = 0\}$

(c) $\{(x, y, z) \in R^3 \mid x \geq 0, y \geq 0\}$

(d) $\{(x, y, z) \in R^3 \mid x - 1 = 0, y = 0\}$

Q.4 Which of the following sets of functions from R to R is a vector space over R?

$$S_1 = \{f \mid \lim_{x\to 3} f(x) = 0\}$$

$$S_2 = \{g \mid \lim_{x\to 3} g(x) = 1\}$$

$$S_3 = \{h \mid \lim_{x\to 3} h(x) exists\}$$

(a) Only S_1 (b) Only S_2

(c) S_1 and S_3 but not S_2

(d) All the three vector spaces

Q.5 Let M_n denote the vector space of all $n \times n$ real matrices. Among the following subsets of M_n, decide which are linear subspaces.

(a) $V_1 = \{A \in M_n : A \text{ is non-singular}\}$

(b) $V_2 = \{A \in M_n : \det(A) = 0\}$

(c) $V_3 = \{A \in M_n : \text{trace}(A) = 0\}$

(d) $V_3 = \{BA : A \in M_n\}$, where B is some fixed matrix in M_n.


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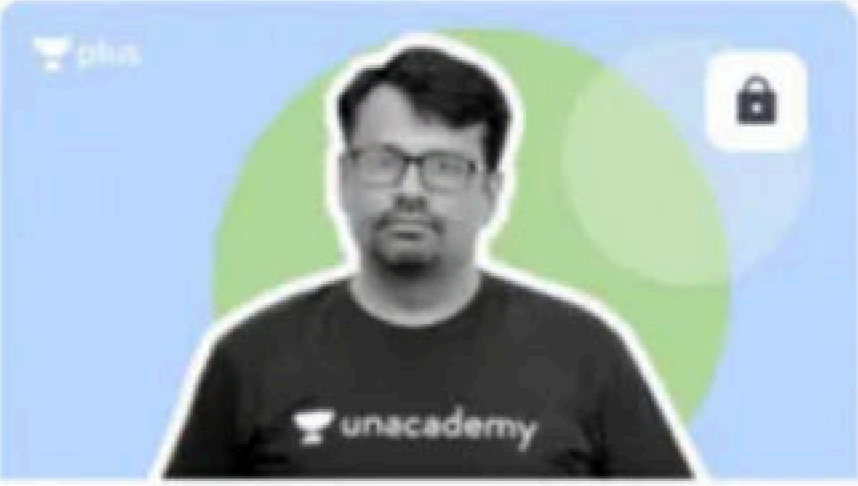

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Educator highlights

- Works at **Pacific Science College**
- Studied at **M.Sc., NET, PhD(Algebra), MBA(Finance), BEd**
- PhD, NET | Plus Educator For CSIR NET | Youtuber (260K+Subs.) | Director Pacific Science College |
- Lives in **Udaipur, Rajasthan, India**
- Unacademy Educator since

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