

MATH 4130-5130 Autumn 2023 Lecture 6

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Subspaces

Consider $P(F)$ as above. Then the zero vector is simply the zero polynomial 0 (where “ 0 ” is the zero element of the field F). If $f(x) = a_0 + a_1x + \cdots + a_nx^n$ is nonzero, then we define the **degree** of $f(x)$ to be the largest value of m for which $a_m \neq 0$. For example, $f(x) = 1 + x + x^2 + 0x^3$ has degree 2. We define the degree of the zero polynomial to be -1 (there are good reasons to do this; one such reason appears below).

Example

Let F be a field and let n be a non-negative integer. Moreover, let $P_n(F)$ be the set of all polynomials of degree at most n . Prove that $P_n(F)$ is a subspace of $P(F)$.

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Proof.

Let F be a field and let $P_n(F)$ be defined as above. We check the three conditions:

Subspaces

Example

Let $V = \mathcal{F}(\mathbb{R}, \mathbb{R})$ and let W be the subset of V consisting of the functions which are continuous on \mathbb{R} .

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Subspaces

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(1) The zero vector of V is in W : as noted above, the zero vector of V is the function $f: \mathbb{R} \rightarrow \mathbb{R}$ defined by $f(x) = 0$ for every real number x .

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(3) W is closed under scalar multiplication: let $f \in W$ and $r \in \mathbb{R}$. Now let $s \in \mathbb{R}$ be arbitrary. Then we have $\lim_{x \rightarrow s} (rf)(x) = \lim_{x \rightarrow s} rf(x) = r \lim_{x \rightarrow s} f(x) = rf(s) = (rf)(s)$, and so rf is continuous at an arbitrary real number s . It follows that $rf \in W$. □