

MATH 601 (DUE 11/6)

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1. GALOIS THEORY II (P.2)

Exercise. (Problem 1) Let $f(x) \in F[x]$ be an irreducible polynomial of degree d . Let $F \subset K$ be a field extension such that $f(x)$ factors as a product of linear polynomials in $K[x]$. Show that $f(x)$ is separable if and only if there exist d distinct F -algebra homomorphisms, $F[x]/(f(x)) \rightarrow K$.

Proof. Without loss of generality, assume $f(x)$ is monic and $f(x) = \prod_{i=1}^d (x - a_i)$ for some $a_i \in K$.

Suppose $f(x)$ is separable. Then $a_i \neq a_j$ for all $i \neq j$. For each i , let $\phi_i : F[x]/(f(x)) \rightarrow K$ be an F -algebra homomorphism such that $x \mapsto a_i$ and $a \mapsto a$ for all $a \in F$. Then each ϕ_i is distinct because $\phi_i(x) \neq \phi_j(x)$ whenever $i \neq j$. Thus we showed the existence of d distinct F -algebra homomorphisms.

Show the other direction.

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