1 => 2

$\{u_1,...,u_n\}$ - linearly independent. Let we have $\exists u_{i+1} = au_1 + bu_2 + ... + cu_i \neq 0$
Then $au_1 + bu_2 + ... + cu_i + (-1)u_{i+1} = 0$, so there is nonzero scalar combination that subsystem of U is linearly dependent. Then U itself is linearly dependent. – contradiction. So, 2) holds.

2) => 3)

Let we have $\exists u_i = au_1 + bu_2 + ... + cu_{i-1} + du_{i+1} + ... + eu_n \neq 0$.
Then if $e \neq 0$ then $\exists u_n = (-e^{-1})(au_1 + bu_2 + ... + cu_{i-1} - u_i + du_{i+1} + ... + fu_{n-1}) \neq 0$ - so u_n is linear combination of elements $\{u_1,....,u_{n-1}\}$. – contradiction to 2).
Thus similar observation leads us to fact that all coefficients near $u_{i+1},...,u_n$ are zeros, and thus $u_i = au_1 + bu_2 + ... + cu_{i-1} \neq 0$.
Last fact contradicts 2) again, and so 3) holds.

3) => 1)
If system $\{u_1,...,u_n\}$ is linearly dependent then one of the vectors is a linear combination of other ones, but this is impossible since 3) holds, so U is linearly independent.