

Call a polynomial  $P(x_1, \dots, x_k)$  *good* if there exist  $2 \times 2$  real matrices  $A_1, \dots, A_k$  such that

$$P(x_1, \dots, x_k) = \det \left( \sum_{i=1}^k x_i A_i \right).$$

Find all values of  $k$  for which all homogeneous polynomials with  $k$  variables of degree 2 are good.  
(A polynomial is homogeneous if each term has the same total degree.)