

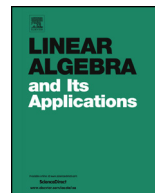


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# Canonical form for the refined Wiener–Hopf equivalence relation for nonsingular $3 \times 3$ polynomial matrices

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## ABSTRACT

We obtain a canonical form for the left  $(2,1)$ -Wiener–Hopf equivalence at infinity for polynomial matrices of order 3. This equivalence relation appears in a problem of structured perturbation when we consider polynomial matrix representations associated with controllable pairs.

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## 1. Introduction

In the problem of characterization of the feedback equivalence classes of the pairs  $(A, [B_1 \ B'_2])$  obtained from  $(A, [B_1 \ B_2])$  by means of small additive perturbations made on the matrix  $B_2$  when  $(A, B_1)$  is controllable, we have obtained an equivalence relation suitable for the problem (see [2]), in such a way that if the structured perturbation problem is solved for a pair it is also solved for any pair in its equivalence class. That equivalence relation is called  $(n, m_1, m_2)$ -equivalence. In that paper we obtained a canonical form for the mentioned equivalence relation, which allowed us to solve the perturbation problem in some particular cases.

In [3], taking into account that we can associate with each controllable pair a nonsingular polynomial matrix, called polynomial matrix representation of the pair, we have defined an equivalence relation in the set of nonsingular polynomial matrices, in such a way that two pairs are  $(n, m_1, m_2)$ -equivalent if and only if their corresponding polynomial matrix representations are equivalent for this new relation. This equivalence relation is called left  $(m_1, m_2)$ -Wiener–Hopf equivalence at infinity, because it is finer than the left Wiener–Hopf equivalence at infinity. Moreover, we have found a reduced form for this refined equivalence relation.

In this paper we obtain a canonical form for the left  $(2, 1)$ -Wiener–Hopf equivalence at infinity.

The organization of the paper is the following one: in Section 2 we give the main notation, definitions and previous results; in Section 3 we present the reduced form for the left  $(m_1, m_2)$ -Wiener–Hopf equivalence at infinity relation and, in the particular case when  $m_2 = 1$ , we obtain some conditions for the elements of the matrices which relate two reduced forms; in Section 4 we obtain a canonical form for this equivalence relation in the particular case when  $m_1 = 2$  and  $m_2 = 1$ .

## 2. Notation, definitions and previous results

A *partition* is a finite or infinite sequence of nonnegative integers almost all zero,  $a = (a_1, a_2, \dots)$ , in nonincreasing order. The *conjugate partition* of  $a$ ,  $\bar{a} = (\bar{a}_1, \bar{a}_2, \dots)$ , is defined by  $\bar{a}_k := \text{Card}\{i : a_i \geq k\}$ . We define  $a \cup b$  to be the partition whose components are those of  $a$  and  $b$  arranged in nonincreasing order.

We will denote by  $\mathbb{F}$  an arbitrary field, by  $\mathbb{F}^{m \times n}$  the set of matrices of size  $m \times n$  and by  $\text{Gl}_n(\mathbb{F})$  the group of invertible matrices of size  $n \times n$ .

For a given matrix pair  $(A, B) \in \mathbb{F}^{n \times n} \times \mathbb{F}^{n \times m}$ ,  $\mathcal{C}(A, B) = [B \ AB \ \dots \ A^{n-1}B]$  denotes the *controllability matrix* of  $(A, B)$ . This pair is said to be completely controllable if  $\text{rank}(\mathcal{C}(A, B)) = n$ .

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