1 Controllability of Matrices with Prescribed Blocks

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Let F be a field and let $n, p_1, \ldots, p_k$ be positive integers such that $n = p_1 + \cdots + p_k$. Let

$$(C_1, C_2) = \left(\begin{bmatrix} C_{1,1} & \cdots & C_{1,k-1} \\ \vdots & & \vdots \\ C_{k-1,1} & \cdots & C_{k-1,k-1} \end{bmatrix}, \begin{bmatrix} C_{1,k} \\ \vdots \\ C_{k-1,k} \end{bmatrix} \right)$$

where the blocks $C_{i,j}$ are of type $p_i \times p_j, i \in \{1, \ldots, k-1\}, j \in \{1, \ldots, k\}$. We study the possibility of (C_1, C_2) being completely controllable, when some of its blocks are fixed and the others vary. Our main results analyse the following cases: (i) All the blocks $C_{i,j}$ are of the same size; (ii) The blocks $C_{i,j}$ are not necessarily of the same size and $k = 3$. We also describe the possible characteristic polynomial of a matrix of the form

$$C = \begin{bmatrix} C_{1,1} & \cdots & C_{1,k} \\ \vdots & & \vdots \\ C_{k,1} & \cdots & C_{k,k} \end{bmatrix}$$

when some of its blocks are prescribed and the others are free.