

Homomorphisms of matrix semigroups

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We study non-degenerate homomorphisms from the multiplicative semigroup of all n -by- n matrices over a field to the semigroup of m -by- m matrices over the same field. In the case $n = 2$ and $m = 3$ we characterise all such homomorphisms. Then we restrict to an algebraically closed field of characteristic zero. We characterise all non-degenerate irreducible homomorphisms in the case $n = 2$ and $m = 4$. If $n = 2$ and a non-degenerate irreducible homomorphism maps a cyclic unipotent to a cyclic unipotent it is the composition of a symmetric power, a field homomorphism used entrywise, and a matrix conjugation. If $n \geq 3$ and $m = n + 1$, every non-degenerate homomorphism is reducible.