Regular Handicap Tournaments of Odd Order

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A graph G with the vertex set $V(G)$, edge set $E(G)$ and $|V(G)| = n$ is called *distance magic* if there exists a bijection $f : V \to \{1, 2, \ldots, n\}$ such that the *weight* of each vertex x, defined as

$$w(x) = \sum_{xy \in E(G)} f(y),$$

is equal to the same *magic constant* μ. The labeling is called a *distance magic labeling*.

A *handicap distance antimagic labeling* of a graph $G(V, E)$ with n vertices is a bijection $\vec{f} : V \to \{1, 2, \ldots, n\}$ with the property that $\vec{f}(x_i) = i$ and the sequence of vertex weights $w(x_1), w(x_2), \ldots, w(x_n)$ forms an increasing arithmetic progression with difference one. A graph G is a *handicap distance antimagic graph* if it allows a handicap distance antimagic labeling.

The notions of distance magic and handicap distance antimagic labelings are closely related to *fair* and *handicap incomplete round robin tournaments*.

The spectrum of all pairs (n, r) for which there exists an r-regular handicap distance antimagic graph with n vertices has been completely determined for even n by Froncek, Kovar, Kovarova, and Shepanik. For odd n, some sporadic results were known due to the first author. We will present some new classes of handicap distance antimagic graphs with odd number of vertices. Our construction is based on a generalization of magic rectangles, called *regular semi-magic rectangle sets*.

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