HADAMARD MATRICES OF ORDERS 116 AND 232[1]

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A *Hadamard matrix* H is a square matrix of *ones* and *minus ones* whose row (and hence column) vectors are orthogonal. The order n of a Hadamard matrix is necessarily 1, 2 or $4t$, for some positive integer t. It has been conjectured that this condition ($n=1$, 2 or $4t$) also insures the existence of a Hadamard matrix. Constructions have been given for particular values of n and even for various infinite classes of values. While other constructions exist, those given in (2) and the references of (1) exhaust the previously known values of n. In this note we construct a Hadamard matrix of order 116, the smallest unsolved case. Taking the tensor product of this matrix with the Hadamard matrix of order 2 yields a Hadamard matrix of order 232, also previously unsolved. This leaves $n=188$ as the only unknown case less than 200.

The matrix of order 116 is of the Williamson type, i.e.

$$H = \begin{vmatrix} A & B & C & D \\ -B & A & -D & C \\ -C & D & A & -B \\ -D & -C & B & A \end{vmatrix}$$

where each of A, B, C, D is a symmetric circulant of order 29. We specify the first rows below (here $+$ stands for $+1$ and $-$ for -1).

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
A	+	+	−	−	+	−	−	+	−	+	+	+	−	+	+	+	+	−	+	+	+	−	+	−	−	+	−	−	+
B	+	+	+	+	−	+	+	−	+	−	−	−	+	+	+	+	+	+	−	−	−	+	−	+	+	−	+	+	+
C	+	+	+	−	−	−	+	+	−	−	+	−	+	−	−	−	−	+	−	+	−	−	+	+	−	−	−	+	+
D	+	−	+	−	−	−	+	+	−	−	+	−	+	+	+	+	+	+	−	+	−	−	+	+	−	−	−	+	−

REFERENCES

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2. H. Ehlich, *Neue Hadamard-Matrizen*, Arch. Math. **16** (1965), 34–36.

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