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Zeros of Certain Bessel Functions of Fractional Order

The following tables contain the zeros of $J_\nu(x)$ for $x \leqslant 25$, where $\nu = \pm 1/3, \pm 2/3, \pm 1/4, \pm 3/4$. These zeros were obtained by inverse interpolation in a thirteen-place manuscript of these functions, computed by the NYMTP. The accuracy of the zeros to 10D is guaranteed, and the two additional places have a high probability of being correct.

s	$j_{+1/4,s}$	$j_{-1/4,s}$
1	2.78088 77239 95	2.00629 96717 90
2	5.90614 26988 43	5.12306 27427 46
3	9.04238 36635 83	8.25795 11756 42
4	12.18134 15289 55	11.39646 76969 87
5	15.32136 98260 12	14.53629 98843 38
6	18.46192 72456 89	17.67675 35868 47
7	21.60278 44489 13	20.81754 94222 32
8	24.74382 77961 28 (24.740)	23.95855 34952 86 (23.955)

s	$j_{+3/4,s}$	$j_{-3/4,s}$
1	3.49100 83741 08	1.05850 82594 04
2	6.65263 55231 22	4.28405 38127 24
3	9.80161 23591 40	7.44045 44040 05
4	12.94703 48891 39	10.58817 91486 60
5	16.09096 95281 99	13.73311 84505 74
6	19.23414 17604 82	16.87681 75138 75
7	22.37687 15748 16 (22.384)	20.01985 75839 86
8		23.16250 59340 75 (23.169)

s	$j_{+1/3,s}$	$j_{-1/3,s}$
1	2.90258 62484 17	1.86635 08588 74
2	6.03274 70572 66	4.98785 32314 35
3	9.17050 66694 64	8.12426 53819 40
4	12.31019 37716 45	11.26351 48254 28
5	15.45064 89678 17	14.40377 58801 36
6	18.59148 63361 81	17.54451 06557 21
7	21.73254 11617 47	20.68550 48061 24
8	24.87373 14228 06 (24.871)	23.82665 62470 57 (23.824)

s	$j_{+2/3,s}$	$j_{-2/3,s}$
1	3.37561 06526 94	1.24304 62596 19
2	6.53025 59365 13	4.42912 06776 99
3	9.67658 06352 38	7.57945 84465 30
4	12.82060 86784 66	10.72474 69244 99
5	15.96368 38809 06	13.86837 45833 31
6	19.10627 35045 92	17.01125 45001 33
7	22.24858 23933 60 (22.253)	20.15373 45371 51
8		23.29597 58670 60 (23.300)

For $x > 25$, ten or more decimal places in the zeros may be obtained from the well-known formula (five terms) for the roots of Bessel functions, given below; see, for example, G. N. WATSON, *Treatise on the Theory of Bessel Functions*, 1922 and 1944, p. 506; the sixth term was supplied by W. G. BICKLEY,[1] *Phil. Mag.*, s. 7, v. 34, 1943, p. 40:

$$j_{\nu,s}=\beta-\frac{\mu-1}{2^3\beta}-\frac{(\mu-1)(7\mu-31)}{3\cdot 2^7\cdot\beta^3}-\frac{(\mu-1)(83\mu^2-982\mu+3779)}{15\cdot 2^{10}\cdot\beta^5}$$
$$-\frac{(\mu-1)(6949\mu^3-153855\mu^2+1585743\mu-6277237)}{105\cdot 2^{15}\cdot\beta^7}$$
$$-\frac{(\mu-1)(70197\mu^4-24\,79316\mu^3+480\,10494\mu^2-5120\,62548\mu+20921\,63573)}{315\cdot 2^{18}\cdot\beta^9}-\cdots,$$

where $\beta=(s+\frac{1}{2}\nu-\frac{1}{4})\pi$; $\mu=4\nu^2$. The first five terms of the above expression will yield at least 10 decimals for roots greater than those given here. The values of β corresponding to the highest roots given here are noted in parenthesis; it is apparent that for x close to 25, β approximates the root to two decimals at least.

The author desires to express his appreciation of assistance rendered by several members of the NYMTP in checking these values.

MILTON ABRAMOWITZ

NYMTP

[1] It may be noted that in Bickley's article the fifth term of the formula has an erroneous number 6277327, for 6277237.