

UNIVERSITY OF ILLINOIS  
DIGITAL COMPUTER

LIBRARY ROUTINE R 6 - 320

TITLE: Fractional Power Routine (DOI or SADOI)  
TYPE: Closed  
NUMBER OF WORDS: 18  
TEMPORARY STORAGE: 6 words, 0-5  
ACCURACY:  $\pm t \times 2^{-38}$ , where t is such that  $(1-A) = 2^{-30}$   
4t milliseconds =  $120 / -\log_2 (1-A)$  milliseconds  
DESCRIPTION: This routine replaces the contents of the accumulator A by  $A^x$ , where x is the 18th word (17L) of the routine and must be preset. The binomial expansion for  $(1+A-1)^x$  is used:  
$$(1 + [A-1])^x = 2[1/2 + x(A-1)/2 + x(x-1)(A-1)^2/2.2! : \dots]$$
$$= 2[u_0 + u_1 + u_2 \dots]$$
Consequently if A is small the accuracy is low and the duration of the calculation long.  
RESTRICTIONS:  $2^{-7} \leq A \leq 1 - 2^{-36}$   
 $0 < x < 1$   
NOTE 1:  $A^x/2$  is left in location 0.  
NOTE 2: This routine is a revision of old R3 - 106 which was found to be in error.

DATE	<u>June 5, 1961</u>
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LOCATION	ORDER	NOTES	PAGE 1	R 6
	OOK (R6)			
0	L4 16L	$N(3) = A-1$		
	40 3F			
1	40 3F	waste		
	K5 F	Plant link		
2	42 15L	address		
	89 1F	-1 in A		
3	L4 17L			
	10 1F			
4	L4 16L	$N(4) = (x+1)/2$		
	40 4F			
5	49 1F			
	49 F	$u_0 = s_0 = 1/2$		
6	41 2F	Set $N(2) = n \neq 0$		
	19 18F			
7	L4 2F	$N(2) = n \times 2^{-19}$		
	40 2F			
8	50 1F			
	75 3F	$N(5) = u_n(A-1)$		
9	40 5F			
	10 18F			
10	66 2F	$N R_1 = u_n(A-1)(x+1)/2n$		
	7J 4F			
11	L0 5F	$N(1) = u_{n+1} = u_n(A-1)(x+1)n - u_n$		
	40 1F	$(a-1) = u_n(A-1)(x - [n-1]) / n$		
12	L4 F			
	40 F	$N(0) = s_{n+1} = s_n + u_n$		
13	L3 5F			
	32 14L	Test for end, $u_n = 0$		
14	22 6L	Form next term		
	L5 F	$NR_1 = A^x$		
15	80 1F			
	22 F	Link		
16	80 F			
	00 F	-1		
17	00 F			
	00 F	x		