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SUBJECT: GROUP 61 SUBROUTINE LIBRARY

To: Group 61

From: W. Lone

Date: October 2, 1952

Abstract: Additional subroutines are given and should be appended to M-1631, dated September 5, 1952. Corrections and clarifications of that memorandum are presented.

The following subroutines are included:

- SRL #9 4 x 7 Decimal Display
- #10 Radius Vector & Azimuth Subroutines
- #11 Unscrambling a Word from Magnetic Tape
- #12 Arcsine in Revolutions
- #13 Sine-Cosine Subroutine

SRL #4 ARCSINE COMPUTATION has been corrected as follows:

106 ad 137
137 0.200000

It is pointed out that since θ , which lies between $-\frac{\pi}{8}$ and $+\frac{\pi}{8}$, has a scale factor of 2^{-2} , $\arcsin x$ lies between $-\frac{\pi}{2}$ and $+\frac{\pi}{2}$.

In SRL #3 the constant 0.11404 in register 202 is $\frac{b}{4}$.

The following corrected subroutine is included: SRL #4 Arcsine Computation.

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Attached forms:

- SRL #9 4 x 7 Decimal Display
- #10 Radius Vector & Azimuth Subroutines
- #11 Unscrambling a Word from Magnetic Tape
- #12 Arcsine in Revolutions
- #4 Arcsine Computation
- #13 Sine-Cosine Subroutine

Title: SRL #9 4 x 7 DECIMAL DISPLAY

Abstract: Enter with $|N| \times 10^{-k}$ in AC, where k = number of digits to be displayed. No sign is displayed.

100	ta 150	200	0.37301
101	ad 232	201	0.00302
102	ts 1t	202	0.74711
103	ca 224	203	0.40711
104	ts 3t	204	0.07610
105	ca 1t	205	0.43705
106	mh 230	206	0.37311
107	ad 233	207	0.00601
110	td 115	210	0.33311
111	sl 17	211	0.23311
112	ts 1t	212	0.40676
113	sp 114	213	0.77700
114	ta 144	214	0.44706
115	ca----	215	0.44666
116	sp 117	216	0.04377
117	ta 140	217	0.42671
120	ts 2t	220	0.44662
121	cs 227	221	0.76603
122	ts 4t	222	0.44666
123	ca 3t	223	0.44676
124	sl 11	224	p x _o abscissa of desired left extremity of display
125	si 600	225	p x _f abscissa of desired right extremity of display
126	ca 2t	226	p y _o ordinate of upper extremity of display
127	sf 5t	227	p 6
130	su 231	230	p 10
131	ts 2t	231	0.40000
132	ca 5t	232	$1/2 \times 10^{-k}$
133	ad 4t	233	si 200
134	cp 151		
135	ao 3t		
136	ca 2t		
137	sl 1		
140	sp 0		
141	ca 115		
142	ad 230	lt	digits of $ N $ remaining to be displayed
143	td 115	2t	remainder of constant
144	sp 0	3t	present x deflection
145	ao 3t	4t	y counter
146	su 225	5t	sf
147	cp 105		
150	sp 0		
151	ts 4t		
152	ad 226		
153	sl 11		
154	rc 0		
155	sp 126		

Title: SRL #10 RADIUS VECTOR & AZIMUTH SUBROUTINES

Abstract: Enter with $\frac{x}{2}$ in 200, $\frac{y}{2}$ in 201. The output will be $\frac{R}{4}$ in 2t, ϕ in 1t where $-\frac{1}{2} \leq \phi \leq \frac{1}{2}$ revs. Should radius vector alone be desired the changes are 100 to 120; 120 sp 0 with orders beyond 120 not needed.

$$\text{Formula: } R = \sqrt{x^2 + y^2} = a(|x| + |y| - b \frac{|x||y|}{|x| + |y|})$$

$$\phi = \frac{\text{sgn } x}{4} \left[d - c \frac{y - (\text{sgn } y) \frac{b}{2} \frac{|x||y|}{|x| + |y|}}{R} \right]$$

Precision: in R, 0.75%; in ϕ , max. error 1.23 degree.

100	ta 136	200	$\frac{x}{2}$	
101	cm 200	201	$\frac{y}{2}$	
102	ts 1t	202	1.32404	-b/2
103	cm 201	203	0.40172	a/2
104	ad 1t	204	0.37176	c/2
105	ts 2t	205	0.17602	d/2
106	cm 201			
107	mr 1t			
110	mr 202			
111	dv 2t			
112	sl 17			
113	ts 1t			
114	sl 1			
115	ad 2t			
116	mr 203			
117	ts 2t			
120	cs 201			
121	cp 124			
122	ad 1t			
123	sp 125			
124	su 1t			
125	mr 204			
126	dv 2t			
127	sl 15			
130	ad 205			
131	ts 1t			
132	cs 200			
133	cp 136			
134	cs 1t			
135	ts 1t			
136	sp----			

Title: SRL #11 UNSCRAMBLING A WORD FROM MAGNETIC TAPE

Abstract: The word to be unscrambled is in AC, and at the conclusion the unscrambled word is in AC. BR must be clear when entering this subroutine. This subroutine takes about 2.1 milliseconds. The maximum permissible time is 2.5 milliseconds.

100	ta 145	130	ad t ₇
101	clh 22	131	slc 2
102	ts t ₁	132	ad t ₆
103	su t ₁	133	slc 2
104	clh 2	134	ad t ₅
105	ts t ₂	135	slc 2
106	su t ₂	136	ad t ₄
107	clh 2	137	slc 2
110	ts t ₃	140	ad t ₃
111	su t ₃	141	slc 2
112	clh 2	142	ad t ₂
113	ts t ₄	143	clc 2
114	su t ₄	144	ad t ₁
115	clh 2	145	sp 0
116	ts t ₅		
117	su t ₅		
120	clh 2		
121	ts t ₆		
122	su t ₆		
123	clh 2		
124	ts t ₇		
125	su t ₇		
126	clc 2		
127	slc 2		

Title: SRL #12 ARCSINE IN REVOLUTIONS

Abstract: Enter with x in AC ($-1 < x < 1$). The output of $\phi = \arcsin x$ in revolutions is in AC where ($-1/4 < \phi < 1/4$). The maximum error is about .001 rev \approx .5 degree.

100	ta 131	200	0.40000
101	ts 1t	201	1.35330
102	cm 1t	202	0.55340
103	ts 2t	203	1.50100
104	cs 2t	204	0.20000
105	sr 2		
106	ad 204		
107	sp 100 (SRL #7)		
110	ts 3t		
111	ca 2t		
112	mh 203		
113	sr 1		
114	ad 202		
115	mh 2t		
116	sr 2		
117	ad 201		
120	mh 2t		
121	sr 3		
122	ad 200		
123	mr 3t		
124	su 204		
125	ts 3t		
126	ca 1t		
127	cp 132		
130	cm 3t		
131	sp 0		
132	ca 3t		
133	sp 131		

Title: SRL #4 ARCSINE COMPUTATION

Abstract: Enter with x in AC, $0 \leq x < 1$. The output is $\theta = 2^{-2} (\sin^{-1} x)$ radians in AC ($-\frac{\pi}{8} \leq \theta \leq \frac{\pi}{8}$). It follows then that $-\frac{\pi}{2} \leq \sin^{-1} x \leq +\frac{\pi}{2}$. This must be used in conjunction with "Square Root Sub-program," SRL #7.

Precision: Maximum error about .001 radian.

100	ta 127	126	cm 3t
101	ts 1t	127	sp 0
102	cm 1t	130	ca 3t
103	ts 2t	131	sp 127
104	cs 2t	132	+.7853
105	sr 2	133	-.2121
106	ad 137	134	+.0743
107	sp 100 (SRL #7)	135	-.0187
110	ts 3t	136	+.3927
111	ca 2t	137	0.20000
112	mr 135		
113	ad 134		
114	mr 2t		
115	ad 133		
116	mr 2t		
117	sr 1		
120	ad 132		
121	mr 3t		
122	su 136		
123	ts 3t		
124	ca 1t		
125	cp 130		

Title: SRL #13 SINE-COSINE SUBROUTINE

Abstract: This variation of SRL #1 enables one to enter the subroutine with θ such that $-1/2 \leq \theta \leq +1/2$ or $0 \leq \theta < +1$ measured from East. θ should be in AC when entering the routine. Output will be $\sin \theta$ in 200, $\cos \theta$ in 201.

100	ta 125	200	sin θ
101	sp 102	201	sin θ , cos θ
102	ta 123	202	0.34540
103	cl 1	203	0.71301
104	ts 200	204	0.03671
105	cm 200	205	0.30647
106	ts t_1	206	0.20000
107	mr 202		
110	su 203		
111	mr t_1		
112	ad 204		
113	mr t_1		
114	ad 205		
115	mh 200		
116	sl 3		
117	ex 201		
120	ex 200		
121	cl 31		
122	sa 206		
123	sp 0		
124	sl 0 (clears spec. add mem.)		
125	sp 0		