

A
COLLECTION
of
AVIATION PROGRAMS

used by



MBC FLIGHT DEPT.

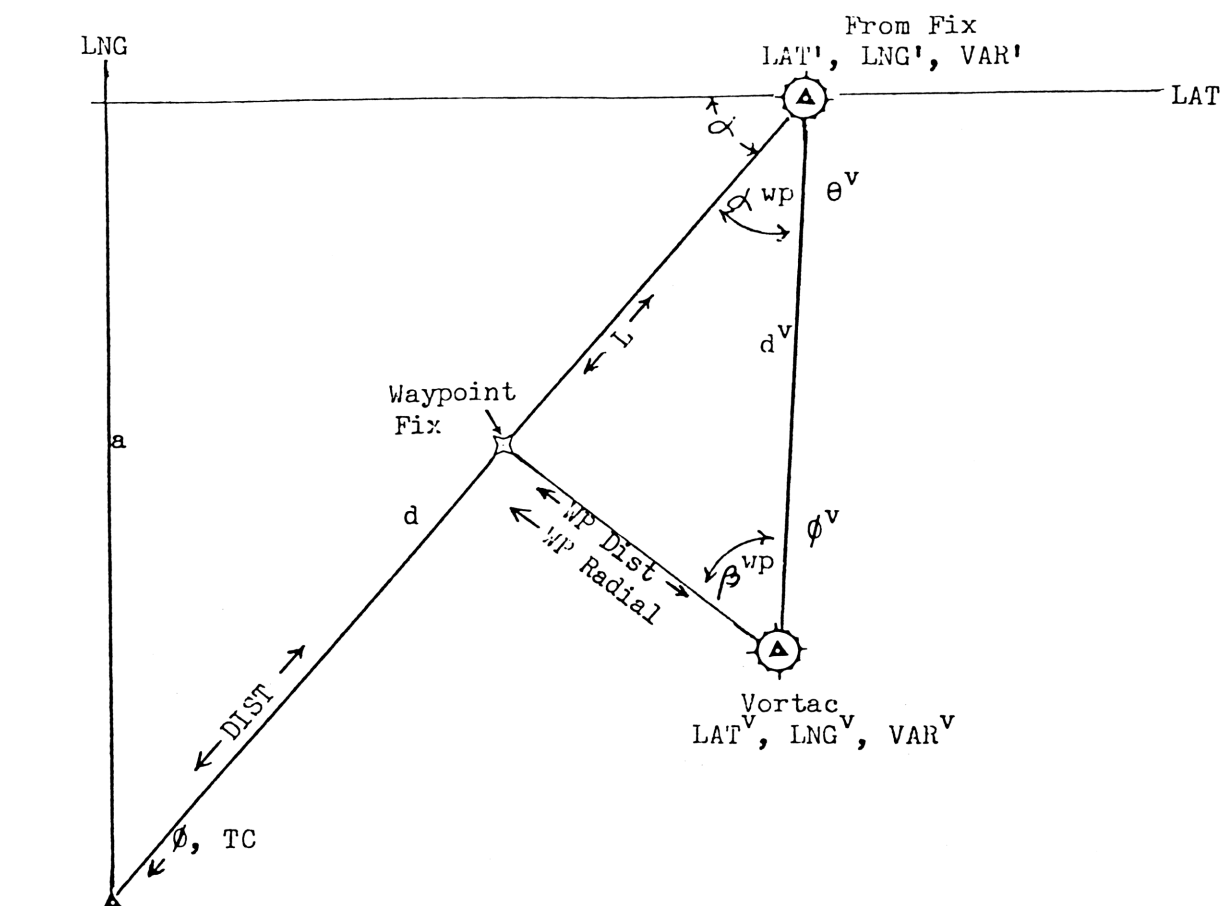
P.O. BOX 643 • STATE UNIVERSITY, AR 72467



ROBERT A. TIMS
(501) 935-7586

by: Robert A. Tims

DIAGRAM & EQUATIONS



To Fix
LAT, LNG, VAR

$$WP Radial = \theta^v \pm \beta^{wp} + VAR^v$$

$$WP Dist = 60 \sin^{-1}(\sin |\alpha^{wp}| \sin d^v)$$

$$LAT = LAT' + \sin^{-1}(\sin d \cos \phi)$$

$$LNG = LNG' - \sin^{-1} \frac{(\sin d \sin \phi)}{\cos (LAT - LAT')/2}$$

$$DIST = 60 d$$

$$d = \cos^{-1}((\sin LAT \sin LAT' + \cos LAT \cos LAT' \cos (LNG - LNG'))$$

$$a = \cos^{-1}(\sin LAT \sin LAT' + \cos LAT \cos LAT')$$

$$\phi = TC = 270^\circ + \alpha \text{ or } 90^\circ - \alpha$$

$$\alpha = \frac{\sin a}{\sin d}$$

PROGRAM DESCRIPTION

Program Title NAVIGATION

Contributor's Name Robert A. Tims

Address _____

City _____ State/Country _____ Zip Code _____

Program Description, Equations, Variables This program computes course and distance from one fix to another along with intermediate waypoints. Each leg data is displayed as the data is calculated. A waypoint may be calculated over the first and the final fixes.

Any prompt, except for the first one (FROM?) may be declined by resuming program execution with no input. When an input is declined the program will terminate that part and move on to the next phase.

Necessary Accessories Card reader and Printer is recommended

Operating Limits and Warnings Destination must not be point of departure.

[illegible]

LBL "NAV"
END
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PROGRAM LISTING

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STEP/ LINE	KEY ENTRY	COMMENTS	STEP/ LINE	KEY ENTRY	COMMENTS
01	LBL "NAV"		49	ARCL 10	
02	CF 05	Initialize	50	"T TO WP?"	
03	CF 06		51	CF 23	
04	CF 09		52	XEQ 03	Coordinates
05	SF 21		53	FC? 23	
06	CF 29		54	GTO 01	
07	ADV		55	"WP:"	
08	"FROM?"		56	ARCL 06	
09	SF 08		57	ASTO 06	
10	SF 23		58	XEQ 10	
11	XEQ 03	Coordinates	59	STO 02	ϕ^v
12	CF 08		60	180	
13	CLX		61	+	θ^v
14	STO 15		62	90	
15	RCL 06		63	RCL 00	ϕ
16	STO 14	Departure Ident	64	RCL 02	
17	FC?C 07	Not a WP?	65	-	α^{wp}
18	XEQ 11	Terminal WP	66	1	
19	FIX 0		67	P-R	$-180^\circ \leq \alpha^{wp} \leq 180^\circ$
20	LBL 20	Primary Legs	68	R-P	
21	ADV		69	RDN	
22	CLA		70	X<0?	
23	ARCL 06		71	SF 05	$ \alpha^{wp} $
24	ASTO 10		72	ABS	
25	"T TO?"		73	STO 02	β^{wp}
26	CF 23		74	-	
27	XEQ 03	Coordinates	75	X<=0?	WP behind starting fix?
28	FC? 23		76	GTO 21	
29	GTO 22		77	STO 03	
30	XEQ 10	TC & Distance	78	FC?C 05	
31	STO 00	ϕ	79	CHS	
32	RCL 02	Distance	80	+	
33	RND		81	RCL 11	VAR^v
34	ST+ 15	T/Distance	82	+	WP Radial
35	STO 05	Leg Distance	83	X<> 03	β^{wp}
36	RCL 11		84	SIN	
37	STO 31	Store Primary fix	85	RCL 01	$\sin d^v$
38	RCL 12		86	*	
39	STO 32		87	ASIN	
40	RCL 13		88	60	
41	STO 33		89	*	
42	RCL 06		90	RND	L
43	STO 34		91	RCL 05	
44	0		92	X<=Y?	WP beyond ending fis?
45	STO 04		93	GTO 21	
46	SF 09		94	X<>Y	
47	LBL 21	Secondary Legs	95	RCL 04	
48	CLA		96	X>Y?	WP behind last WP?

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STEP/ LINE	KEY ENTRY	COMMENTS	STEP/ LINE	KEY ENTRY	COMMENTS
97	GTO 21		145	-	
98	RDN		146	STO 12	Secondary leg distance
99	ENTER↑	L	147	CLA	
100	X<> 04	WP Distance	148	ARCL 10	
101	XEQ 02	Leg output	149	FC? 55	
102	ADV		150	GTO 00	
103	FIX 1		151	ACA	
104	CLA		152	CLA	
105	ARCL 06		153	SF 13	
106	XEQ 15	Output	154	" TO "	• Preface
107	CLA		155	ACA	
108	RCL 03	WP Radial	156	CF 13	
109	XEQ 12	Azimuth format	157	CLA	
110	"-,"		158	LBL 00	
111	RCL 02	$ \alpha^{WP} $	159	FC? 55	
112	SIN		160	"-"	
113	RCL 01	$\sin d^V$	161	ARCL 06	
114	*		162	XEQ 15	
115	ASIN		163	"MC="	
116	00		164	RCL 00	∅
117	*		165	RCL 07	VAR'
118	ARCL X		166	+	MC'
119	"- NM"	WP Radial Distance	167	STO 13	
120	XEQ 15	Output	168	XEQ 12	Azimuth format
121	RCL 11		169	RCL 13	MC'
122	STO 07	VAR update	170	RCL 00	∅
123	ADV		171	RCL 11	VAR
124	FIX 0		172	+	MC
125	RCL 06		173	X*Y?	
126	STO 10		174	"-/"	
127	GTO 21		175	X*Y?	
128	LBL 01		176	XEQ 12	Azimuth format
129	CF 09		177	XEQ 15	Output
130	RCL 31		178	"DIST="	
131	STO 11	VAR update	179	ARCL 12	Leg Distance
132	RCL 34		180	"- NM"	
133	STO 06		181	GTO 15	Output
134	RCL 05		182	LBL 03	Coordinate Input Subroutine
135	RCL 04		183	13	
136	XEQ 02	Leg output	184	FS? 08	
137	RCL 11		185	9	
138	STO 07		186	LBL 04	
139	RCL 32	Recall Primary Fix	187	STO 01	
140	STO 08		188	LBL 05	
141	RCL 33		189	AON	
142	STO 09		190	PROMPT	
143	GTO 20		191	AOFF	
144	LBL 02	Leg Output Subroutine	192	FC? 23	

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STEP/ LINE	KEY ENTRY	COMMENTS	STEP/ LINE	KEY ENTRY	COMMENTS
193	RTN		241	ASTO Y	
194	FC? 09		242	CLA	
195	CF 07		243	ARCL 06	
196	ASTO 06		244	X*Y?	
197	16.03003		245	GTO 07	
198	STO 02		246	10	
199	STO 03		247	STO 02	
200	XEQ 06	Search for data	248	35.4952	
201	FS?C 05	Found?	249	STO 11	
202	RTN		250	-903847.04	
203	RCL 03		251	STO 12	
204	STO 02		252	GTO 08	
205	SF 25		253	LBL 07	Ident Search
206	AON		254	RCL 06	
207	RDTAX		255	RCL IND 02	
208	AOFF		256	X=Y?	
209	CF 25		257	GTO 08	
210	XEQ 07	Search for data	258	ISG 02	
211	FS?C 05	Found?	259	GTO 07	
212	RTN		260	RTN	
213	CF 22		261	LBL 08	Decode coordinates
214	CLA		262	SF 05	
215	ARCL 06		263	1	
216	"F LAT?"		264	ST+ 02	
217	PROMPT		265	RCL IND 02	
218	CLA		266	HR	
219	ARCL 06		267	STO IND 01	
220	FC? 22		268	DSE 01	
221	GTO 09		269	1	
222	HR		270	ST+ 02	
223	STO IND 01		271	RCL IND 02	
224	DSE 01		272	FRC	
225	CLA		273	LASTX	
226	ARCL 06		274	INT	
227	"F LNG?"		275	ABS	
228	PROMPT		276	1 E4	
229	HR		277	/	
230	STO IND 01		278	HR	
231	DSE 01		279	STO IND 01	
232	CLA		280	DSE 01	
233	ARCL 06		281	RDN	
234	"F VAR?"		282	100	
235	PROMPT		283	*	
236	STO IND 01		284	STO IND 01	
237	RTN		285	RTN	
238	LBL 06	JBR?	286	LBL 09	Intersection coordinates
239	RCL 06		287	FC? 09	WP?
240	"JBR"		288	FS? 06	Reference fix?

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STEP/ LINE	KEY ENTRY	COMMENTS	STEP/ LINE	KEY ENTRY	COMMENTS
289	GT0 03		337	ST0 09	
290	RCL 07		338	LASTX	
291	ST0 11		339	+	
292	RCL 08		340	2	
293	ST0 12	Prior fix to be used for	341	/	
294	RCL 09	the reference fix if	342	COS	
295	ST0 13	needed.	343	/	
296	RCL 06		344	ST- 12	
297	ST0 31		345	RCL 12	LNG
298	SF 06	Referance fix flag	346	FS? 08	
299	CF 23		347	ST0 08	
300	13		348	SF 07	
301	"NEED FIX?"		349	RTN	
302	XEQ 04	Reference coordinates	350	*LBL 10	TC & Distance Subroutine
303	CF 06		351	RCL 13	
304	RCL 31		352	SIN	
305	ST0 06		353	RCL 09	
306	"FIX MC?"		354	SIN	
307	PROMPT		355	*	Sin LAT Sin LAT'
308	CLA		356	ST0 01	
309	ARCL 06		357	RCL 13	
310	SF 23		358	COS	
311	FC? 22		359	RCL 09	
312	GT0 03		360	COS	
313	RCL 11		361	*	Cos LAT Cos LAT'
314	FS? 08		362	ST0 02	
315	ST0 07		363	+	
316	-		364	ACOS	
317	ST0 01		365	SIN	
318	"FIX DIST?"		366	RCL 13	
319	PROMPT		367	RCL 09	
320	60		368	-	
321	/	d	369	SIGN	+ Northerly
322	SIN		370	*	- Southerly
323	ST0 02	Sin d	371	RCL 02	
324	RCL 01	Ø	372	RCL 12	
325	SIN		373	RCL 08	
326	*		374	-	
327	ASIN		375	X<0?	+ Westerly
328	RCL 01		376	SF 05	- Easterly
329	COS		377	COS	
330	RCL 02		378	*	
331	*		379	RCL 01	
332	ASIN		380	+	
333	RCL 13		381	ACOS	d
334	+		382	SIN	Sin d
335	ST0 13	LAT	383	ST0 01	
336	FS? 08		384	LASTX	

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STEP/ LINE	KEY ENTRY	COMMENTS	STEP/ LINE	KEY ENTRY	COMMENTS
385 60			433 "F NM"		
386 *	DIST		434 GTO 15		Output
387 STO 02			435*LBL 12		Azimuth Subroutine
388 RDN			436 360		
389 /			437 MOD		
390 ASIN	α		438 X#0?		
391 FS? 05			439 GTO 00		
392 CHS			440 LASTX		
393 90			441 +		
394 +			442*LBL 00		
395 100			443 100		
396 FS?C 05			444 X>Y?		
397 CLX			445 "F0"		
398 +	ϕ		446 SORT		
399 RTN			447 X>Y?		
400*LBL 11	Terminal WP Subroutine		448 "F0"		
401 RCL 06			449 ARCL Y		
402 STO 10			450 FC? 55		
403 CLA			451 RTN		
404 ARCL 06			452 ACA		
405 "F WP?"			453 0		Degree Character
406 SF 09	Computing WP flag		454 ENTER↑		
407 CF 23			455 BLDSPEC		
408 XEQ 03	Coordinates		456 6		
409 CF 09			457 BLDSPEC		
410 FC? 23			458 9		
411 RTN			459 BLDSPEC		
412 "WP:"			460 9		
413 ARCL 06			461 BLDSPEC		
414 ASTO 06			462 9		
415 CLA			463 BLDSPEC		
416 ARCL 10			464 6		
417 "F * "	WP Preface		465 BLDSPEC		
418 ARCL 06			466 ACSPEC		
419 XEQ 15	Output		467 CLA		
420 CLA			468 RTN		
421 RCL 10			469*LBL 22		
422 STO 06			470 FC?C 07		Not a WP?
423 XEQ 10	ϕ^v		471 XEQ 11		Terminal WP
424 100			472 ADV		
425 +	θ^v		473 CLA		
426 RCL 11	VAR ^v		474 ARCL 14		
427 +			475 "F TO "		
428 FIX 1			476 ARCL 34		
429 XEQ 12	Azimuth format		477 AVIEW		
430 "F, "			478 FIX 0		
431 RCL 02	d^v		479 "T/DIST "		
432 ARCL X			480 ARCL 15		

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[illegible]

PROGRAM DESCRIPTION I

Program Title Aviation Navigation

Contributor's Name Robert A. Tims

Address _____

City _____

State/Country _____

Zip Code _____

Program Description, Equations, Variables This program computes course and distance from one fix to another along with intermediate waypoints. The individual legs and the associated data is stored in proper sequence, each leg in 5 data registers.

Wind and altitude is prompted for. If altitude input is declined, the prior altitude is entered. The prior altitude is displayed in the prompt. The winds aloft, above and below the altitude, are prompted for; the lower wind first. If input is declined, the prior leg's wind is entered. Input cannot be declined the first leg or when the altitude is changed. If the upper wind is declined, the input for the lower wind is used. The wind at the flight level is interpolated from the input winds. Winds are entered in the same format is given in the winds aloft forecast.

When a fix input is declined the program will terminate that part and move on to the next phase. "FROM?" prompt input cannot be declined.

Necessary Accessories Card Reader is recommended.

Operating Limits and Warnings Destination must not be point of departure.

PROGRAM DESCRIPTION II

Sample Problem (Sketch if Desired)

Flight: Depart Pine Bluff airport and fly direct to Hille intersection than direct to Jonesboro airport. Climb to 3500' until the waypoint off of Little Rock VOR than climb to 7500'. Hille intersection is PBI03466.

Winds:	<u>3000</u>	<u>6000</u>	<u>9000</u>
LIT	1512	1718	2022
MEM	1810	2118	2525

Data from WBAZ: Fuel is 118 Gal.
GW is 5,091 lbs.

Terminal fixes off of PBF VOR and Gilmore VOR.

SOLUTION:

		Comments
R10= 54		
R14= 7500		
R15= 118		
R19= 206		
R20= 150.012		
R21= 262		
R22= 189.0123493		
R31= -4		
R33= WP:GQE		
R34= 3402.030189		
R35= 118		
R36= 5091		
R37= WP:PBF		
R38= 1822.004358		
R39= PBF		
R40= 1211.027575		
R41= 36.017		
R42= -3500.004		
R43= 153.013		
R44= WP:LIT		
R45= 0		
R46= 36.053		
R47= -7500.005		
R48= 185.020		
R49= HILLE		
R50= 0		
R51= 27.048		
R52= -7500.004		
R53= 230.0215		
R54= JBR		
LOAD AVFLY		
		PERTINENT DATA REGISTERS
		AVNAV RESULTS USED LATER IN THE AVFLY PROGRAM

REGISTERS, STATUS, FLAGS, ASSIGNMENTS

[illegible]

PROGRAM LISTING

STEP/ LINE	KEY ENTRY	COMMENTS	STEP/ LINE	KEY ENTRY	COMMENTS
01	LBL "AVNAV"		49	STO 04	
02	FIX 0		50	SF 09	Computing WP's
03	CF 05		51	LBL 21	Secondary Legs
04	CF 06		52	CLA	
05	CF 09		53	ARCL IND 10	
06	CF 29		54	"- TO WP?"	
07	"FROM?"		55	CF 23	
08	SF 08		56	XEQ 01	WP Coordinates
09	SF 23		57	FC? 23	
10	XEQ 01	Coordinates	58	GTO 22	
11	CF 08		59	XEQ 07	TC & Distance
12	RCL 06		60	STO 02	ϕ^V
13	STO 03 33		61	100	
14	CLX		62	+	θ^V
15	STO 14	Initialize	63	90	
16	STO 15		64	RCL 00	ϕ
17	STO 38		65	RCL 02	α^{wp}
18	38		66	-	
19	FC?C 07	Not a WP?	67	1	
20	XEQ 08	Terminal WP	68	P-R	$-180^\circ \leq \alpha^{wp} \leq 180^\circ$
21	RCL 03 33		69	R-P	
22	STO 06	Recall ident	70	RDN	
23	39		71	X<0?	
24	STO 10	Leg counter value	72	SF 05	$ \alpha^{wp} $
25	LBL 20	Primary leg	73	ABS	
26	CLA		74	STO 02	β^{wp}
27	ARCL 06		75	-	
28	ASTO IND 10		76	X<=0?	WP behind starting fix?
29	"- TO?"		77	GTO 21	
30	CF 23		78	STO 03	
31	XEQ 01	Coordinates	79	FC?C 05	
32	FC? 23		80	CHS	
33	GTO 23		81	+	
34	XEQ 07	TC & Distance	82	RCL 11	VAR^V
35	STO 00	ϕ	83	+	WP radial
36	RCL 02	Distance	84	X<> 03	β^{wp}
37	RND		85	SIN	
38	ST+ 15	T/Distance	86	RCL 01	$\sin d^V$
39	STO 05	Leg distance	87	*	
40	RCL 11		88	ASIN	
41	STO 31	Store primary fix	89	60	
42	RCL 12		90	*	
43	STO 32		91	RND	L
44	RCL 13		92	STO 12	
45	STO 33		93	RCL 05	
46	RCL 06		94	X<=Y?	WP beyond ending fix?
47	STO 34		95	GTO 21	
48	0		96	X<>Y	

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STEP/ LINE	KEY ENTRY	COMMENTS	STEP/ LINE	KEY ENTRY	COMMENTS
97	RCL 04		145	STO 09	
98	X>Y?	WP behind last WP?	146	RCL 34	
99	GTO 21		147	STO 06	
100	1		148	GTO 20	
101	ST+ 10		149	LBL 23	
102	RCL 03	WP radial	150	CLX	
103	360		151	STO 34	
104	MOD		152	34	
105	10		153	FC?C 07	Not a WP?
106	*		154	XEQ 08	Terminal WP
107	RND		155	CLX	
108	RCL 02		156	STO 01	
109	SIN		157	"DEPT EL?"	
110	RCL 01		158	PROMPT	
111	*		159	STO 19	
112	ASIN		160	RCL 42	Leg #1 Altitude
113	.06	WP Dist/103	161	INT	
114	*		162	ABS	
115	+	WP Fix	163	+	
116	STO IND 10		164	2	
117	1		165	/	Average Climb altitude
118	ST+ 10		166	XEQ 11	Wind Data
119	RCL 12	L	167	STO 20	Climb Wind
120	ENTER↑		168	CLX	
121	X<> 04	WP Distance	169	STO 01	
122	XEQ 09	Leg Data	170	"DEST EL?"	
123	RCL 11		171	PROMPT	
124	STO 07	Update variation	172	STO 21	
125	"WP:"		173	RCL 14	Last Altitude
126	ARCL 06		174	+	
127	ASTO IND 10	WP Ident	175	2	
128	GTO 21		176	/	Average Descent altitude
129	LBL 22		177	XEQ 11	Wind Data
130	CF 09		178	STO 22	Descent Wind
131	1		179	RCL 35	
132	ST+ 10		180	"T/FUEL="	
133	0		181	ARCL X	
134	STO IND 10		182	"t?"	
135	1		183	PROMPT	
136	ST+ 10		184	STO 35	
137	RCL 05	Leg Distance	185	RCL 36	
138	RCL 04	WP Distance	186	"GW="	
139	XEQ 09	Leg Data	187	ARCL X	
140	RCL 31		188	"t?"	
141	STO 07		189	PROMPT	
142	RCL 32		190	STO 36	
143	STO 08	Recall primary fix	191	"*LOAD AVFLY*"	
144	RCL 33		192	PROMPT	

PROGRAM LISTING

STEP/ LINE	KEY ENTRY	COMMENTS	STEP/ LINE	KEY ENTRY	COMMENTS
193*	LBL 01	Coordinate Input Subroutine	241	STO IND 01	
194	13		242	DSE 01	
195	FS? 08		243	CLA	
196	9		244	ARCL 06	
197*	LBL 02		245	"F VAR?"	
198	STO 01		246	PROMPT	
199*	LBL 03		247	STO IND 01	
200	AON		248	RTN	
201	PROMPT		249*	LBL 04	JBR?
202	AOFF		250	RCL 06	
203	FC? 23		251	"JBR"	
204	RTN		252	ASTO Y	
205	FC? 09		253	CLA	
206	CF 07		254	ARCL 06	
207	ASTO 06		255	X=Y?	
208	16.03003		256	GTO 05	
209	STO 02		257	10	
210	STO 03		258	STO 02	
211	XEQ 04	Search for Data	259	35.4952	
212	FS?C 05	Found?	260	STO 11	
213	RTN		261	-903847.04	
214	RCL 03		262	STO 12	
215	STO 02		263	GTO 00	
216	SF 25		264*	LBL 05	Data search
217	AON		265	RCL 06	
218	RDTAX	Load Data	266	RCL IND 02	
219	AOFF		267	X=Y?	
220	CF 25		268	GTO 00	
221	XEQ 05	Search for Data	269	ISG 02	
222	FS?C 05	Found?	270	GTO 05	
223	RTN		271	RTN	
224	CF 22		272*	LBL 00	Decoding Coordinate Data
225	CLA		273	SF 05	
226	ARCL 06		274	1	
227	"F LAT?"		275	ST+ 02	
228	PROMPT		276	RCL IND 02	
229	CLA	Coordinate prompts	277	HR	
230	ARCL 06		278	STO IND 01	
231	FC? 22		279	DSE 01	
232	GTO 06		280	1	
233	HR		281	ST+ 02	
234	STO IND 01		282	RCL IND 02	
235	DSE 01		283	FRC	
236	CLA		284	LASTX	
237	ARCL 06		285	INT	
238	"F LNG?"		286	ABS	
239	PROMPT		287	1 E4	
240	HR		288	/	

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STEP/ LINE	KEY ENTRY	COMMENTS	STEP/ LINE	KEY ENTRY	COMMENTS
289	HR		337	*	
290	STO IND 01		338	ASIN	
291	DSE 01		339	RCL 01	
292	RDN		340	COS	
293	100		341	RCL 02	
294	*		342	*	
295	STO IND 01		343	ASIN	
296	RTN		344	RCL 13	
297	*LBL 06	Intersection Coordinates	345	+	
298	FC? 09	WP?	346	STO 13	LAT
299	FS? 06	Reference fix?	347	FS? 08	
300	GTO 01		348	STO 09	
301	RCL 07		349	LASTX	
302	STO 11		350	+	
303	RCL 08		351	2	
304	STO 12		352	/	
305	RCL 09		353	COS	
306	STO 13		354	/	
307	RCL 06		355	ST- 12	
308	STO 31		356	RCL 12	LNG
309	SF 06	Reference fix flag	357	FS? 08	
310	CF 23		358	STO 08	
311	13		359	SF 07	
312	"NEED FIX?"		360	RTN	
313	XEQ 02	Reference coordinates	361	*LBL 07	TC & Distance Subroutine
314	CF 06		362	RCL 13	
315	RCL 31		363	SIN	
316	STO 06		364	RCL 09	
317	"FIX MC?"		365	SIN	
318	PROMPT		366	*	Sin LAT Sin LAT'
319	CLA		367	STO 01	
320	ARCL 06		368	RCL 13	
321	SF 23		369	COS	
322	FC? 22		370	RCL 09	
323	GTO 01		371	COS	
324	RCL 11		372	*	Cos LAT Cos LAT'
325	FS? 08		373	STO 02	
326	STO 07		374	+	
327	-		375	ACOS	
328	STO 01	∅	376	SIN	
329	"FIX DIST?"		377	RCL 13	
330	PROMPT		378	RCL 09	
331	60		379	-	+ Northerly
332	/	d	380	SIGN	- Southerly
333	SIN		381	*	
334	STO 02	Sin d	382	RCL 02	
335	RCL 01	∅	383	RCL 12	
336	SIN		384	RCL 08	

PROGRAM LISTING

STEP/ LINE	KEY ENTRY	COMMENTS	STEP/ LINE	KEY ENTRY	COMMENTS
385 -	-	Westerly	433 I E3		
386 X<0?	-	Easterly	434 /		
387 SF 05			435 +		Terminal WP Fix
388 COS			436 STO IND 05		
389 *			437 DSE 05		
390 RCL 01			438 "WP:"		
391 +			439 ARCL 06		
392 ACOS	d		440 ASTO IND 05		
393 SIN			441 RTN		
394 STO 01			442*LBL 09		Leg Data Display
395 LASTX			443 -		
396 60			444 I E3		Distance/1E3
397 *	Distance		445 /		
398 STO 02			446 RCL 00		∅
399 RDN			447 RND		
400 /			448 +		Crs.Dis
401 ASIN	α		449 STO IND 10		
402 FS? 05			450 I		
403 CHS			451 ST+ 10		
404 90			452 "ALT="		
405 +			453 ARCL 14		
406 180			454 "I?"		
407 FS?C 05			455 RCL 14		
408 CLX			456 CF 22		
409 +	∅		457 PROMPT		
410 RTN			458 RND		
411*LBL 08	Terminal WP		459 STO 14		
412 STO 05			460 FS? 22		New Altitude?
413 CLA			461 SF 06		
414 ARCL 06			462 RCL 07		VAR
415 "I WP?"			463 I E3		
416 SF 09			464 /		
417 CF 23			465 SIGN		
418 XEQ 01	Coordinates		466 X<>Y		
419 CF 09			467 LASTX		
420 FC? 23			468 ABS		
421 RTN			469 +		
422 XEQ 07	∅ ^v		470 *		Alt.Var
423 180			471 STO IND 10		
424 +	θ ^v		472 I		
425 RCL 11	VAR ^v		473 ST+ 10		
426 +			474*LBL 10		
427 360			475 CLX		
428 MOD			476 STO 01		
429 10			477 RCL 14		Altitude
430 *			478 XEQ 11		Wind
431 RND			479 FS? 22		Wind entry?
432 RCL 02	Distance		480 GTO 00		

PROGRAM LISTING

STEP/ LINE	KEY ENTRY	COMMENTS	STEP/ LINE	KEY ENTRY	COMMENTS
481	43		529	XEQ 12	Lower Wind
482	RCL 10		530	FC? 22	
483	X*Y?	First Leg?	531	RTN	
484	FS? 06	New Altitude?	532	STO 01	
485	GTO 10		533	RCL 02	
486	5		534	XEQ 12	Upper Wind
487	-		535	STO 02	
488	RCL IND X	Prior wind	536	INT	
489	+LBL 00		537	RCL 01	
490	STO IND 10		538	INT	Interpolation of
491	1		539	-	wind direction & velocity
492	ST+ 10		540	LASTX	
493	CF 06		541	X<>Y	
494	RTN		542	1	
495	+LBL 11	Wind Data	543	P-R	
496	CF 22		544	R-P	
497	1 E3		545	RDN	
498	/		546	RCL 03	
499	30		547	*	
500	X<=Y?	Altitude above 30,000'?	548	+	
501	GTO 12		549	RND	
502	X<>Y		550	360	
503	12		551	MOD	
504	X<>Y		552	RCL 02	
505	X>Y?	Altitude above 12,000'?	553	FRC	
506	SF 05		554	RCL 01	
507	3		555	FRC	
508	ENTER†		556	-	
509	FC?C 05		557	LASTX	
510	CLX		558	X<>Y	
511	+		559	RCL 03	
512	STO 02	Altitude increment	560	*	
513	X>Y?		561	+	
514	GTO 12		562	+	
515	/		563	RTN	
516	FRC		564	+LBL 12	
517	STO 03	Interpolation factor	565	"WA"	
518	X=0?	Altitude below 3,000'?	566	ARCL X	
519	SF 05		567	"t?"	
520	LASTX		568	RCL 01	
521	INT		569	PROMPT	
522	X=0?	Altitude same as forecast	570	RCL 01	
523	1	wind	571	X=Y?	
524	RCL 02		572	RTN	
525	*		573	X<>Y	Decode
526	FS?C 05		574	100	Wind
527	GTO 12		575	/	Format
528	ST+ 02		576	INT	
					577 LASTX
					578 FRC
					579 10
					580 /
					581 X<>Y
					582 LASTX
					583 *
					584 +
					585 END

PROGRAM DESCRIPTION I

Program Title Aztec Flight Data (AVFLY)

Contributor's Name Robert A. Tims

Address _____

City _____ State/Country _____ Zip Code _____

Program Description, Equations, Variables This program utilizes the data generated by the AVNAV (*TIMS*) program to printout the flight data if the flight is made in a Piper Turbo Aztec.

The altitude and winds aloft of the first leg is used throughout the entire climbout, and of the final leg throughout the entire descent.

If the magnetic variation of the leg's ending fix is different than that of the leg beginning fix, both magnetic courses are displayed.

Wind Correction Formulas:

$$WCA = \sin^{-1} Y; GS = TAS \cos WCA - W^V \sin \phi; MH = TC + WCA + VAR$$

$$Y = r \sin \phi; \phi = W^O - TC; r = W^V / TAS$$

P-R Conversion: $Y = r \sin \phi$, $X = r \cos \phi$ then -

$$GS = TAS(\cos WCA - X) = TAS(\cos WCA) - W^V \cos \phi$$

Formulas in pure aviation terms:

$$WCA = \sin^{-1}(W^V \sin(W^O - TC) / TAS)$$

$$GS = TAS \cos WCA - W^V \cos(W^O - TC)$$

Necessary Accessories Printer

Operating Limits and Warnings Data error will be displayed if a level altitude isn't established prior to the final descent or if not enough time to climb to initial altitude prior to descent. TAS must not equal zero.

PROGRAM DESCRIPTION II

Sample Problem (Sketch if Desired)

Output from the AVNAV program.

SOLUTION:

XEQ "AZFLY"		
PBF TO JBR		HILLE to JBR
T/DIST 118 NM		MC=023°
		DIST=48 NM
PBF * WP:PBF		LEVEL AT 7500
182.2°, 4.4 NM		HDC=020°
PBF to WP:LIT	WP:LIT to HILLE	TAS=180
MC=032°/031°	MC=031°/032°	GS=199
DIST=17 NM	DIST=53 NM	DIST=23
WP:LIT	CLIMB 3500 → 7500	REM DIST=25
121.1°, 27.6 NM	HDC=037°	TIME=0:06:55
CLIMB 206 → 3500	TAS=115	T/TIME=0:31:56
HDC=037°	GS=126	DESCENT 7500 → 262
TAS=115	DIST=9	HDC=024°
GS=119	REM DIST=92	TAS=195
DIST=7	TIME=0:04:30	GS=207
REM DIST=111	T/TIME=0:11:35	DIST=25
TIME=0:03:44	LEVEL AT 7500	TIME=0:07:14
LEVEL AT 3500	HDC=034°	T/TIME=0:39:10
HDC=036°	TAS=180	JBR * WP:GOE
TAS=174	GS=197	340.2°, 30.2 NM
GS=179	DIST=44	LANDING WT= 4949 LBS
DIST=10	REM DIST=48	REM FUEL=94 GAL
REM DIST=101	TIME=0:13:26	RESERVE TIME=2:46:22
TIME=0:03:21	T/TIME=0:25:01	
T/TIME=0:07:05		HAPPY FLYING

REGISTERS, STATUS, FLAGS, ASSIGNMENTS

[illegible]

PROGRAM LISTING

STEP/ LINE	KEY ENTRY	COMMENTS	STEP/ LINE	KEY ENTRY	COMMENTS
01	LBL "AZFLY"		49	X<>Y	
02	CF 07	Initialize	50	ST- 11	Descent time used
03	CF 08		51	60	
04	CF 29		52	*	
05	*PRINTER*		53	RCL 00	ROD
06	FC? 55		54	*	
07	PROMPT		55	ST+ 13	Leg's highest altitude
08	FIX 0		56	CLX	
09	RCL 10		57	FS? 06	Error trap: not enough
10	STO 16		58	LN	time.
11	RCL 15		59	RCL 10	
12	STO 27		60	6	
13	RCL 35		61	+	
14	STO 24		62	RCL IND X	
15	RCL 36		63	SIGN	
16	STO 25		64	LASTX	
17	0		65	FRC	Present VAR
18	STO 06		66	ABS	
19	STO 09		67	RCL 21	
20	STO 18		68	RND	
21	2.96295		69	+	
22	ST- 10		70	*	
23	RCL 14	Last altitude	71	STO IND Y	Low Alt.Var
24	STO 23		72	GTO 15	
25	RCL 21	Destination elevation	73	LBL 00	
26	STO 13		74	RCL 02	Ground Speed
27	-		75	*	
28	1 E3		76	RCL 00	
29	STO 00	ROD	77	/	
30	/		78	STO 32	Descent point
31	60		79	RCL 10	
32	/		80	6	
33	STO 11	Time to descend	81	+	
34	195	Descent TAS	82	RCL IND X	
35	STO 07		83	SIGN	
36	LBL 15		84	LASTX	
37	RCL 13	Leg's lowest altitude	85	FRC	Present VAR
38	STO 26		86	ABS	
39	RCL IND 10		87	RCL 14	Last altitude
40	STO 05	Leg Crs.Dis	88	+	
41	SF 06		89	*	
42	DSE 10	SF 06 if Leg#1	90	STO IND Y	Last leg Alt.Var
43	CF 06		91	ADV	
44	RCL 22	Descent wind	92	CLA	
45	XEQ 03	Wind Correction	93	SF 12	
46	RCL 11		94	ARCL 39	
47	X<=Y?	Enough time for descent?	95	"F TO "	Preface
48	GTO 00		96	ARCL IND 16	

PROGRAM LISTING

STEP/ LINE	KEY ENTRY	COMMENTS	STEP/ LINE	KEY ENTRY	COMMENTS
97	AVIEW		145	ISG 10	
98	CF 12		146	STO 11	
99	"T/DIST "		147	"MC="	
100	ARCL 15		148	RCL IND 10	
101	"F NM"		149	ISG 10	
102	PRA		150	STO 05	Crs.Dis
103	ADV		151	INT	TC
104	CLA		152	RCL IND 10	
105	ARCL 39		153	FRC	
106	"F * "		154	RCL 00	
107	ARCL 37		155	*	
108	RCL 38		156	STO 06	VAR
109	X#0?	Terminal WP?	157	+	MC
110	XEQ 06	WP Display	158	STO 12	
111	RCL 19	Departure elevation	159	XEQ 10	Degree format
112	STO 13		160	RCL 16	
113	SF 05	Climbout Flag	161	RCL 10	
114	RCL 10		162	5	
115	INT		163	+	
116	2		164	X>Y?	Last Leg?
117	+		165	SF 08	
118	RCL 00		166	X<Y?	
119	/		167	RCL IND X	
120	39		168	FRC	Next VAR
121	FS?C 06		169	RCL 00	
122	GTO 21		170	*	
123	+		171	FS?C 08	Last leg?
124	STO 10	Leg pointer	172	RCL 31	Last VAR
125	LBL 20		173	RCL 05	
126	ADV		174	INT	TC
127	CLA		175	+	Next MC
128	ARCL IND 10		176	RCL 12	MC
129	ISG 10		177	X<>Y	
130	ACA		178	"/"	
131	CLA	Leg preface	179	X*Y?	Different?
132	SF 13		180	XEQ 10	Degree format
133	" TO "		181	PRBUF	
134	ACA		182	"DIST="	
135	CF 13		183	RCL 05	
136	CLA		184	FRC	
137	RCL 10		185	RCL 00	
138	4		186	*	Leg Distance
139	+		187	STO 08	
140	STO 01		188	ARCL X	
141	ARCL IND X		189	"F NM"	
142	ACA		190	PRA	
143	PRBUF		191	CLA	
144	RCL IND 10		192	ARCL IND 01	Ending fix

PROGRAM LISTING

STEP/ LINE	KEY ENTRY	COMMENTS	STEP/ LINE	KEY ENTRY	COMMENTS
193	RCL 11		241	RND	
194	X*0?	Waypoint?	242	ST- 05	Distance remainder
195	XEQ 06	Display WP	243	FIX 0	
196	ADV		244	CLX	
197	RCL 18	Present wind and altitude	245	FC? 07	Error trap: not enough
198	STO 17	become the previous	246	LN	time for descent
199	RCL 13	wind and altitude.	247	GTO 01	
200	STO 14		248	LBL 00	
201	FS? 05	Climbout?	249	X=0?	Leg distance flown?
202	FC? 07	Descent log?	250	GTO 02	
203	GTO 00		251	LBL 01	
204	RCL 42	Error trap: Climb & Descent	252	5200	
205	INT	altitudes must equal if	253	RCL 36	
206	RCL IND 10	they occur in the same	254	-	
207	INT	leg.	255	.005	
208	X*Y?		256	*	
209	CLX		257	LASTX	
210	/		258	.3	
211	LBL 00		259	*	
212	RCL 42		260	RCL 13	
213	FC? 05		261	*	
214	RCL IND 10	Alt.Var	262	+	
215	ISG 10		263	160	
216	INT		264	+	
217	ABS		265	STO 07	Cruise TAS
218	STO 13	Present altitude	266	RCL IND 10	Wind
219	RCL IND 10		267	FS?C 05	
220	STO 18	Present wind	268	RCL 43	
221	X<>Y		269	XEQ 03	Wind correction
222	RCL 14	Previous altitude	270	34	Cruise F/F
223	FS?C 06		271	*	
224	RTN		272	STO 11	
225	X*Y?	Altitude change?	273	"LEVEL AT "	
226	XEQ 04	Climb/Descend	274	ARCL 13	
227	RCL 05		275	PRA	
228	FRC	Dis/1E3	276	XEQ 07	Display data
229	FC? 07		277	FS?C 07	
230	GTO 00		278	RTN	
231	RCL 32	Descent point	279	LBL 02	
232	X>Y?	Enough time?	280	ISG 10	
233	CF 07		281	GTO 20	
234	RCL 05		282	RCL 10	Present leg
235	INT	TC	283	INT	
236	X<>Y		284	LBL 21	
237	+	Crs.DP	285	RCL 16	
238	STO 32		286	1	
239	LASTX		287	-	
240	FIX 3		288	RCL 00	

PROGRAM LISTING

STEP/ LINE	KEY ENTRY	COMMENTS	STEP/ LINE	KEY ENTRY	COMMENTS
289 /			337 RCL 02		
290 +			338 /		
291 STO 10	Leg pointer		339 STO 03	Time	
292 SF 07	Descent leg flag		340 RTN		
293 XEQ 20			341 LBL 04	Climb/Descend subroutine	
294 195	Descent TAS		342 -	Altitude change	
295 STO 07			343 STO 11		
296 RCL 13	Highest altitude		344 X>0?	Climb?	
297 STO 14			345 SF 06		
298 RCL 26	Lowest altitude		346 45 E5		
299 STO 13			347 RCL 25		
300 RCL 32			348 /	ROC	
301 STO 05			349 FC? 06		
302 GTO 23			350 RCL 00	ROD	
303 LBL 03	Wind Correction Subroutine		351 STO 12		
304 FRC	$W^V/1E3$		352 195	Descent TAS	
305 LASTX			353 FS? 06		
306 INT	W^0		354 115	Climb TAS	
307 RCL 05			355 STO 07		
308 INT	TC		356 RCL 20	Climb Wind	
309 -	θ		357 FS? 05	Climb?	
310 X<>Y			358 GTO 00		
311 RCL 00			359 RCL 18	Present wind	
312 *	W^V		360 INT		
313 RCL 07	TAS		361 RCL 17	Previous wind	
314 /	r		362 INT		
315 P-R	$r \cos \theta$		363 -		
316 RDN	$r \sin \theta$		364 LASTX		
317 ASIN	WCA		365 X<>Y		
318 COS			366 1		
319 Rt	$r \cos \theta$		367 P-R	Calculate average W^0	
320 LASTX	WCA		368 R-P		
321 RCL 05			369 RDN		
322 INT	TC		370 2		
323 +			371 /		
324 RCL 06	VAR		372 +		
325 +			373 RND		
326 STO 04	MH		374 RCL 18		
327 RDN	Cos WCA		375 FRC		
328 -	Cos WCA - X		376 RCL 17		
329 RCL 07	TAS		377 FRC	Calculate average W^V	
330 *			378 -		
331 STO 02	GS		379 LASTX		
332 RCL 05			380 X<>Y		
333 FRC			381 2		
334 RCL 00			382 /		
335 *			383 +		
336 STO 01	Distance		384 +	Average Wind	

PROGRAM LISTING

STEP/ LINE	KEY ENTRY	COMMENTS	STEP/ LINE	KEY ENTRY	COMMENTS
385*LBL 00			433 125		
386 XEQ 03	Wind correction		434 ACCHR		
387 RCL 11	Altitude change		435 RCL 13		
388 ABS			436 ACX		
389 RCL 12	Vertical speed		437 PRBUF		
390 /			438 GTO 07	Display data	
391 60			439*LBL 06	WP Display Subroutine	
392 /	Total time needed		440 ADV		
393 X<Y?	Not enough time?		441 PRA		
394 GTO 00			442 CLA		
395 STO 03	Climb/Descend time		443 STO 12		
396 RCL 02	Ground speed		444 FIX 1		
397 *			445 INT		
398 RND			446 10		
399 STO 01	Climb/Descend distance		447 /		
400 RCL 00			448 XEQ 10		
401 /	Dist/1E3		449 ", "		
402 GTO 01			450 RCL 12		
403*LBL 00			451 FRC		
404 X<>Y	Available time		452 RCL 00		
405 60			453 *		
406 *			454 ARCL X		
407 RCL 12	Vertical speed		455 "F NM"		
408 *			456 ACA		
409 FC? 06	Descent?		457 PRBUF		
410 CHS			458 FIX 0		
411 RCL 14	Starting altitude		459 RTN		
412 +			460*LBL 07	Display	
413 STO 13	Ending altitude		461 RCL 11		
414 RCL 05			462 ST- 24	Subtract fuel used	
415 FRC	Dist/1E3		463 6		
416*LBL 01			464 *		
417 ST- 05			465 ST- 25	GW - Fuel used	
418 24	Descent F/F		466 "HDG="		
419 FS? 06			467 RCL 04		
420 54	Climb F/F		468 XEQ 10	Degree format	
421 RCL 03	Time		469 PRBUF		
422 *			470 "TAS="		
423 STO 11	Fuel used		471 ARCL 07		
424 "CLIMB"			472 PRA		
425*LBL 05	Descent display		473 "GS="		
426 FC?C 06			474 ARCL 02		
427 "DESCENT"			475 PRA		
428 ACA			476 "DIST="		
429 RCL 14			477 ARCL 01		
430 ACX			478 RCL 08	Leg distance	
431 1			479 RCL 01	distance	
432 SKPCHR			480 RND		

TINS

1090 BYTES

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PROGRAM LISTING

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STEP/ LINE	KEY ENTRY	COMMENTS	STEP/ LINE	KEY ENTRY	COMMENTS
481	X*Y?		529	360	
482	PRA		530	MOD	
483	ST- 27		531	X*0?	
484	"REM DIST="		532	GTO 00	
485	ARCL 27		533	LASTX	
486	RCL 27		534	+	
487	X>0?	Distance left?	535	*LBL 00	
488	PRA		536	100	
489	FIX 4		537	X>Y?	
490	RCL 03	Time	538	"F0"	
491	HMS		539	SQRT	
492	RND		540	X>Y?	
493	HR		541	"F0"	
494	STO 03		542	ARCL Y	
495	ST+ 09		543	ACA	
496	FIX 0		544	0	
497	CLA		545	ENTER↑	Degree
498	XEQ 08		546	BLDSPEC	Character
499	"T/"		547	6	
500	RCL 03		548	BLDSPEC	
501	RCL 09		549	9	
502	X*Y?		550	BLDSPEC	
503	XEQ 08	Time display	551	9	
504	ADV		552	BLDSPEC	
505	RTN		553	9	
506	*LBL 08	Time Display	554	BLDSPEC	
507	HMS		555	6	
508	INT		556	BLDSPEC	
509	"F-TIME="		557	ACSPEC	
510	ARCL X		558	RTN	
511	10		559	*LBL 22	Descent continues
512	XEQ 09		560	SF 06	
513	X<>Y		561	XEQ 20	
514	XEQ 09		562	*LBL 23	
515	PRA		563	RCL 22	Descent wind
516	RTN		564	XEQ 03	Wind correction
517	*LBL 09	Time Format	565	24	Descent F/F
518	"F:"		566	*	
519	LASTX		567	STO 11	Fuel used
520	FRC		568	XEQ 05	Descent display
521	100		569	ISG 10	
522	*		570	GTO 22	
523	X<Y?		571	CLA	
524	"F0"		572	ARCL IND 16	
525	INT		573	"F * "	
526	ARCL X		574	ARCL 33	
527	RTN		575	RCL 34	
528	*LBL 10	Degree Format	576	X*0?	Terminal WP?
			577	XEQ 06	Display WP
			578	ADV	
			579	RCL 25	Rem. Wt.
			580	"LANDING WT= "	
			581	ARCL X	
			582	"F LBS"	
			583	PRA	
			584	RCL 24	Rem. fuel
			585	RND	
			586	"REM FUEL="	
			587	ARCL X	
			588	"F GAL"	
			589	X>0?	Fuel left?
			590	PRA	
			591	LASTX	
			592	34	Cruise F/F
			593	/	
			594	X<0?	
			595	CLX	
			596	STO 12	
			597	"RESERVE "	
			598	XEQ 08	Time Display
			599	ADV	
			600	"HAPPY FLYING"	
			601	SF 12	
			602	RCL 12	Fuel time
			603	.75	
			604	X>Y?	
			605	"FUEL TOO LOW"	
			606	BEEP	
			607	AVIEW	
			608	CF 12	
			609	RCL 16	Initialize
			610	STO 10	for
			611	RCL 23	reprint
			612	STO 14	
			613	ADV	
			614	END	

PROGRAM DESCRIPTION I

Program Title Data Record

Contributor's Name _____

Address _____

City _____ State/Country _____ Zip Code _____

Program Description, Equations, Variables This program prompts for navigation fix data, encodes it, and writes it on a magnetic card. The recorded data includes the facility identifier, latitude & longitude coordinates, and the magnetic variation. Each facility takes 3 data registers, so a total of five facilities may be recorded on each track. The data, after it is input may be reviewed for correctness and changed if needed. After the data is input and after it has been viewed, the program prompts to write it on a card. If a card track is loaded by simply inserting it into the card reader, that data will can be viewed. Anytime the program prompts for the ident, if input is declined, the program will proceed to view the contents.

REGISTERS, STATUS, FLAGS, ASSIGNMENTS

DATA REGISTERS			STATUS			
00 to			SIZE 17	TOT. REG.		USER MODE
14 Facility data			ENG	FIX	SCI	ON OFF
15 Counter value			DEG X	RAD	GRAD	
16 Identifier						

Necessary Accessories _____

Operating Limits and Warnings If the viewing is terminated while viewing the variation the variation data will be lost from that data register. This isn't important as the data will already have been recorded, unless "DR" is being used in a master program. Terminating the viewing anywhere else will not change the data in the registers.

PROGRAM LISTING

STEP/ LINE	KEY ENTRY	COMMENTS	STEP/ LINE	KEY ENTRY	COMMENTS
01	LBL "DR"		49	ARCL IND 15	
02	.014	Counter value	50	PROMPT	View Identifier/
03	STO 15		51	AOFF	correct & store
04	LBL 01		52	ASTO 16	
05	CF 23		53	ASTO IND 15	
06	"IDENT?"		54	ISG 15	
07	ADN		55	FIX 4	
08	PROMPT		56	RCL IND 15	
09	AOFF		57	CLA	
10	FC?C 23	Input declined?	58	ARCL 16	
11	GTO 03	start viewing data	59	"I="	
12	ASTO 16	Store Ident	60	ARCL X	
13	ASTO IND 15		61	PROMPT	View lat/ correct
14	ISG 15		62	STO IND 15	& store
15	CLA		63	ISG 15	
16	ARCL 16		64	RCL IND 15	
17	"I LAT?"		65	INT	
18	PROMPT		66	ABS	
19	STO IND 15		67	1 E4	
20	ISG 15		68	/	
21	CLA		69	CLA	
22	ARCL 16		70	ARCL 16	
23	"I LNG?"		71	"I="	
24	PROMPT		72	ARCL X	
25	1 E4		73	PROMPT	View lng/ correct
26	*		74	1 E4	& store
27	CLA		75	*	
28	ARCL 16		76	X<> IND 15	
29	"I VAR?"	Code IJG.VAR	77	FIX 1	
30	PROMPT		78	FRC	
31	SIGN		79	100	
32	X<>Y		80	*	
33	LASTX		81	CLA	
34	ABS		82	ARCL 16	
35	100		83	"I="	
36	/		84	ARCL X	
37	+		85	PROMPT	View Var/ correct
38	*		86	100	& store
39	STO IND 15		87	/	
40	ISG 15		88	ABS	
41	GTO 01		89	ST+ IND 15	
42	LBL 02		90	LASTX	
43	.014		91	SIGN	
44	STO 15		92	ST* IND 15	
45	WD TAX	Write data card	93	ISG 15	
46	LBL 03		94	GTO 03	
47	CLA		95	GTO 02	Write data card
48	ADN		96	END	

PROGRAM DESCRIPTION

Program Title Weight and Balance, AZTEC 62773

Contributor's Name Robert A. Tims

Address _____

City _____

State/Country _____

Zip Code _____

Program Description, Equations, Variables This program computes the center of gravity for the Aztec, N62773 and sums up the gross weight. It outputs if weight is over gross and if over zero fuel weight. It calculates the forward CG limit and displays both the forward and aft limits prior to output of the center of gravity.

The forward CG is calculated according to the following formulas:

$$3600 \leq GW \leq 4600 -$$

$$FWD CG = -85.23 + 21.1 \ln(GW)$$

$$4600 < GW < 5000 -$$

$$FWD CG = -211.06 + 36 \ln(GW)$$

$$5000 \leq GW \leq 5200 -$$

$$FWD CG = -642.62 + 86.67 \ln(GW)$$

AZTEC N62773

PILOTS= 175

ROW 1= 410

ROW 2= 150

FWD BAG= 0

AFT BAG= 35

MAX FUEL=136

INBD FUEL= 68

OUTBD FUEL= 50

T/FUEL= 118

CG LIMITS: 97.1 100.5

CG= 98.7

GW= 5091 LBS

VIEW 35

118

VIEW 36

5091

Necessary Accessories Printer is recommended

Operating Limits and Warnings When input is declined, 0 is entered.

Fuel must be entered in gallons.

REGISTERS, STATUS, FLAGS, ASSIGNMENTS

[illegible]

LBL WBAZ
END
TIMS

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PROGRAM LISTING

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STEP/ LINE	KEY ENTRY	COMMENTS	STEP/ LINE	KEY ENTRY	COMMENTS
01	LBL "WBAZ"		50	-	
02	ADV		51	6	
03	SF 22		52	/	
04	FIX 0		53	"MAX FUEL="	
05	CF 29		54	ARCL X	
06	"AZTEC N62773"		55	X<Y?	
07	SF 12		56	AVIEW	
08	AVIEW		57	CLX	
09	CF 12		58	"INBD FUEL="	
10	SF 21		59	XEQ 05	
11	ADV		60	"OUTBD FUEL="	
12	89		61	XEQ 05	
13	STO 00	Store arm moments	62	"T/FUEL="	
14	126		63	ARCL 35	
15	STO 01		64	AVIEW	
16	157		65	RDH	
17	STO 02		66	411.6	
18	10		67	-	
19	STO 03		68	X>0?	Tip tanks used?
20	183		69	XEQ 08	
21	STO 04		70	3613	Empty Weight
22	113		71	ST+ 08	
23	STO 05		72	90	Empty CG
24	STO 06		73	*	
25	-6.3	Tip tank correction	74	RCL 09	
26	STO 07		75	+	
27	CLX		76	RCL 08	
28	STO 08		77	/	
29	STO 09		78	STO 09	CG
30	STO 11		79	4600	
31	STO 35		80	RCL 08	
32	"PILOTS"		81	X<Y?	FWD CG Calculations:
33	XEQ 06		82	GT0 02	
34	"ROW 1"		83	5 E3	
35	XEQ 06		84	X>Y?	
36	"ROW 2"		85	GT0 03	
37	CF 22		86	X<Y	
38	XEQ 06		87	LN	
39	"FWD BAG"		88	86.67	5000# or over
40	XEQ 06		89	*	
41	"AFT BAG"		90	642.62	
42	XEQ 06		91	GT0 04	
43	RCL 08		92	LBL 02	
44	943		93	LN	
45	X<Y?	Over zero fuel weight?	94	21.1	3600# to 4600#
46	XEQ 11		95	*	
47	177	Fuel tank capacity	96	85.23	
48	1587	Useful load	97	GT0 04	
49	RCL 08		98	LBL 03	Between 4600# and 5000#

PROGRAM LISTING

STEP/ LINE	KEY ENTRY	COMMENTS	STEP/ LINE	KEY ENTRY	COMMENTS
99	X<>Y		148	LBL 07	
100	LN		149	ST+ 08	
101	36		150	LBL 08	Moment calculation
102	*		151	RCL IND 11	
103	211.06		152	X<>Y	
104	LBL 04		153	*	
105	-		154	ST+ 09	
106	FIX 1		155	LASTX	
107	"CG LIMITS:"		156	LBL 09	
108	FS? 55		157	1	
109	GTO 00		158	ST+ 11	
110	AVIEW	Ouput CG limits	159	CLX	
111	CLL		160	RTN	
112	ARCL X		161	LBL 10	Slide Row 1 back 6"
113	"F 100.5"		162	SF 22	
114	AVIEW		163	RDN	
115	GTO 01		164	132	
116	LBL 00		165	*	
117	ACA		166	ST+ 09	
118	ACX		167	X<>Y	
119	LBL 01		168	ST- 09	
120	RCL 09		169	GTO 09	
121	CLL		170	LBL 11	Overweight output
122	X<Y?		171	-	
123	"FWD "		172	"OVER WT"	
124	100.5	FWD or AFT CG?	173	FS? 55	
125	FS? 55		174	GTO 12	
126	ACX		175	"F "	
127	X<Y?		176	ARCL X	
128	"AFT "		177	AVIEW	
129	"FCG= "		178	RTN	
130	ARCL Y		179	LBL 12	
131	AVIEW		180	ACA	
132	GTO 13		181	ACX	
133	LBL 05		182	PRBUF	
134	PROMPT		183	RTN	
135	ST+ 35		184	LBL 13	
136	FS? 55		185	FIX 0	
137	XEQ 12		186	"GW= "	
138	6		187	ARCL 08	
139	*	Fuel weight	188	"F LBS"	
140	GTO 07		189	AVIEW	
141	LBL 06		190	RCL 08	
142	"F= "		191	STO 36	
143	PROMPT		192	5200	
144	FS? 55		193	X<Y?	Overgross?
145	XEQ 12		194	XEQ 11	
146	FC? 22	Row 2 empty?	195	END	
147	GTO 10				

LBL'R
LBL'V
END
TIMS

92 BYTES

PROGRAM DESCRIPTION I

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Program Title Groundspeed along MC

Contributor's Name Robert A. Tims

Address _____

City _____

State/Country _____

Zip Code _____

Program Description, Equations, Variables Computes the groundspeed using DME and waypoint data or MC and Omni Bearing data. LBL "R" uses DME and waypoint distance and LBL "V" uses MC and Bearing to or from the VOR. Both methods use the tangential speed readout from the DME.

Necessary Accessories NONE

Operating Limits and Warnings Not very accurate when the bearing from the VOR is perpendicular to the MC or if the aircraft is within 10NM of the waypoint.

LBL'R
 LBL'Y
 END 92 BYTES
 TIMS

PROGRAM LISTING

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FIX 2 ■ 41C

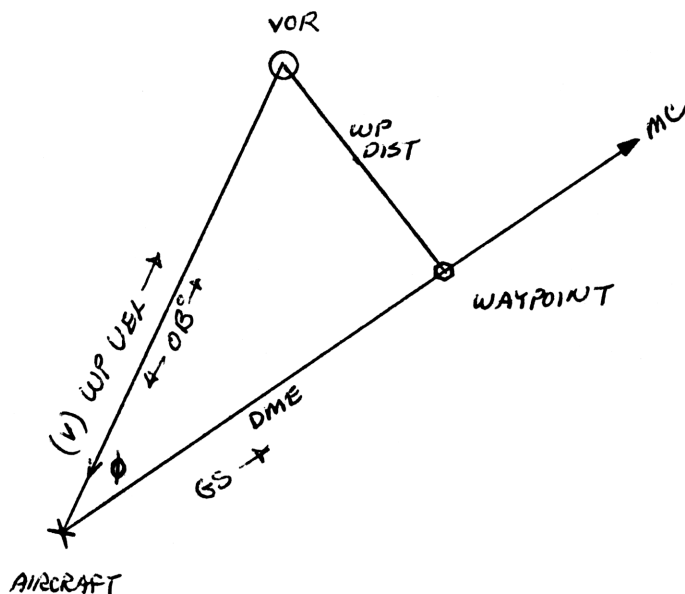
STEP/ LINE	KEY ENTRY	COMMENTS	STEP/ LINE	KEY ENTRY	COMMENTS
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```

01+LBL "R"
02 1
03 STO 00
04 "WP DIST?"
05 PROMPT
06 STO 01
07+LBL 01
08 RCL 01
09 "DME?"
10 PROMPT
11 /
12 X↑2
13 1
14 +
15 SQRT
16 GTO 00
17+LBL "V"
18 2
19 STO 00
20 "MC?"
21 PROMPT
22 STO 01
23+LBL 02
24 RCL 01
25 "OB?"
26 PROMPT
27 -
28 1
29 P-R
30 R-P
31 RDN
32 COS
33 1/X
34 ABS
35+LBL 00
36 "WP VEL?"
37 PROMPT
38 *
39 FIX 0
40 CF 29
41 "GS="
42 ARCL X
43 "HNM"
44 PROMPT
45 GTO IND 00
46 END
  
```

$$V \sec \phi = V \sqrt{1 + \tan^2 \phi} = V \sqrt{1 + \left(\frac{WP \text{ DIST}}{DME}\right)^2}$$

$$= \left| \frac{V}{\cos \phi} \right|$$



PROGRAM DESCRIPTION I

IN-FLIGHT WINDS | HEADWINDS AND CROSSWINDS

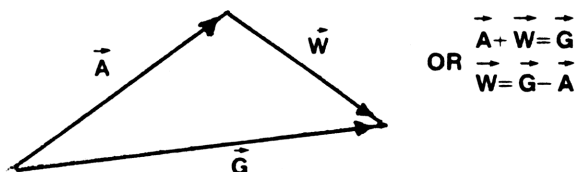
Program Title

This program is actually in two parts: one to determine in-flight winds, and the other to resolve a wind into its headwind or tailwind and right or left crosswind components.

Determining In-Flight Winds

This program computes the winds at altitude from TAS, course of aircraft, ground speed and heading. Ground speed is automatically calculated from time-distance inputs. Winds can be computed as either magnetic or true. The latter must be used when verifying wind forecasts by the weather bureau. The program allows continuous updating of winds.

This program solves the wind triangle shown below.



W, A and G are all vector quantities representing wind direction and speed; TAS and heading; and ground speed and course respectively.

Since both A and G use magnetic directions, W is computed as a magnetic direction. It must be corrected to true heading by adding the variation V.

True wind direction = magnetic wind direction $\rightarrow$ magnetic variation

Headwinds and Crosswinds

Also, this program calculates both the head wind and cross wind components from the aircraft heading and reported winds. The program works both at altitude, where magnetic variation must be considered, and at landing and takeoff, where winds are reported in magnetic directions rather than true directions.

The head wind (HW) and right cross wind (RCW) components are computed from

$$HW = K \cos (D - HDG + V)$$

$$RCW = K \sin (D - HDG + V)$$

where

K = the reported wind velocity

D = the reported wind direction

HDG = the aircraft heading

V = the magnetic variation (+ west, - east)

Necessary Accessories

Operating Limits and Warnings

Wind directions reported by the control tower are magnetic and the variation need not be input when using the program for takeoff and landings. Other wind directions are reported in true directions and variation must be included to find the wind components.

HW= Head Wind
 RCW= RightCross Wind
 TW= Tail Wind
 LCW= Left Cross Wind

LBL'IFW
 LBL'HCW
 END
 TIMS

387 BYTES

PROGRAM LISTING

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STEP/ LINE	KEY ENTRY	COMMENTS	STEP/ LINE	KEY ENTRY	COMMENTS
01	LBL "IFW"		49	P-R	
02	CF 05		50	X<>Y	
03	LBL 01		51	ST- T	
04	CF 29		52	RDN	
05	FIX 1		53	-	
06	ADV		54	R-P	
07	RCL 06		55	RND	
08	"VAR="		56	STO 12	
09	XEQ 03		57	X<>Y	
10	STO 06		58	RCL 06	
11	FC? 55		59	-	
12	GTO 00		60	RND	
13	CLA		61	STO 11	
14	ARCL X		62	SF 21	
15	XEQ 07		63	ADV	
16	LBL 00		64	"WIND DIR="	
17	FIX 0		65	XEQ 06	
18	RCL 04		66	FC? 55	
19	"MH="		67	AVIEW	
20	XEQ 04		68	"WIND VEL="	
21	STO 04		69	ARCL 12	
22	FS? 55		70	FS? 55	
23	XEQ 05		71	GTO 09	
24	FS?C 05		72	CF 21	
25	RTN		73	AVIEW	
26	RCL 05		74	RTN	
27	"MC="		75	GTO 01	
28	XEQ 04		76	LBL "HCW"	
29	STO 05		77	LBL 02	
30	FS? 55		78	SF 05	
31	XEQ 05		79	XEQ 01	
32	RCL 07		80	RCL 11	
33	"TAS="		81	"WIND DIR="	
34	XEQ 03		82	XEQ 04	
35	STO 07		83	STO 11	
36	FS? 55		84	FS? 55	
37	XEQ 08		85	XEQ 05	
38	RCL 02		86	RCL 12	
39	"GS="		87	"WIND VEL="	
40	XEQ 03		88	XEQ 03	
41	STO 02		89	STO 12	
42	FS? 55		90	FS? 55	
43	XEQ 08		91	XEQ 08	
44	RCL 04		92	ADV	
45	RCL 07		93	RCL 11	
46	P-R		94	RCL 04	
47	RCL 05		95	-	
48	RCL 02		96	RCL 06	

LBL*IFW
 LBL*HCW
 END
 TIMS

387 BYTES

PROGRAM LISTING

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STEP/ LINE	KEY ENTRY	COMMENTS	STEP/ LINE	KEY ENTRY	COMMENTS
97	+		145	*LBL 05	
98	RCL 12		146	CLA	
99	P-R		147	*LBL 06	
100	"HW="		148	360	
101	X<0?		149	MOD	
102	"TW="		150	X#0?	
103	ASTO 00		151	GTO 00	
104	ABS		152	LASTX	
105	RND		153	+	
106	X<>Y		154	*LBL 00	
107	"R"		155	100	
108	X<0?		156	X>Y?	
109	"L"		157	"I0"	
110	"I-CW="		158	SQRT	
111	ABS		159	X>Y?	
112	ARCL X		160	"I0"	
113	FC? 55		161	ARCL Y	
114	"I"		162	FS? 21	193 CLA
115	FS? 55		163	FC? 55	194 END
116	XEQ 09		164	RTN	
117	ARCL 00		165	*LBL 07	
118	ARCL Y		166	ACA	
119	FS? 55		167	0	
120	XEQ 09		168	ENTER↑	VAR=-7.5°
121	CF 21		169	BLDSPEC	MH=165°
122	AVIEW		170	6	MC=150°
123	SF 21		171	BLDSPEC	TAS=110kts
124	RTN		172	9	GS=120kts
125	GTO 02		173	BLDSPEC	
126	*LBL 03		174	9	WIND DIR=273°
127	FS? 55		175	BLDSPEC	WIND VEL=32kts
128	ACA		176	9	
129	ARCL X		177	BLDSPEC	VAR=-7.5°
130	"I?"		178	6	MH=165°
131	PROMPT		179	BLDSPEC	WIND DIR=273°
132	RND		180	ACSPEC	WIND VEL=32kts
133	RTN		181	PRBUF	
134	*LBL 04		182	RTN	RCW=31kts
135	FS? 55		183	*LBL 08	TW=6kts
136	ACA		184	CLA	
137	CF 21		185	ARCL X	VAR=0.0°
138	XEQ 06		186	*LBL 09	MH=280°
139	SF 21		187	ACA	WIND DIR=240°
140	"I?"		188	SF 13	WIND VEL=25kts
141	RDN		189	"KTS"	
142	PROMPT		190	ACA	LCW=16kts
143	RND		191	PRBUF	HW=19kts
144	RTN		192	CF 13	

TRIGONOMETRY

TRIGONOMETRIC FUNCTIONS IN A RIGHT-ANGLED TRIANGLE

If A, B, and C are the vertices (C the right angle), and a, b, and h the sides opposite respectively,

$$\begin{aligned} \text{sine } A &= \sin A = \frac{a}{h}, & \text{cosine } A &= \cos A = \frac{b}{h}, \\ \text{tangent } A &= \tan A = \frac{a}{b}, & \text{cotangent } A &= \cot A = \text{ctn } A = \frac{b}{a}, \\ \text{secant } A &= \sec A = \frac{h}{b}, & \text{cosecant } A &= \csc A = \frac{h}{a}. \end{aligned}$$

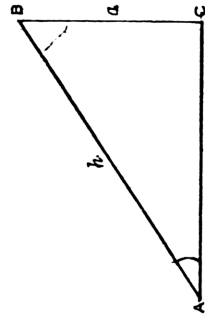


Fig. 4

$$\begin{aligned} \text{exsecant } A &= \text{exsec } A = \sec A - 1 \\ \text{versine } A &= \text{vers } A = 1 - \cos A \\ \text{coversine } A &= \text{covers } A = 1 - \sin A \\ \text{haversine } A &= \text{hav } A = \frac{1}{2} \text{ vers } A \end{aligned}$$

RELATIONS BETWEEN DEGREE OF ACCURACY OF COMPUTED LENGTHS AND ANGLES

When solving a triangle for any of its parts the following should be observed:

Length to:	(requires)	Angle to:
2 significant digits		nearest 30' = 0.5°
3 significant digits		nearest 05' = 0.083°
4 significant digits		nearest 01' = 0.0167°
5 significant digits		nearest 0.1' = 0.00167°

SIGNS AND LIMITS OF VALUE ASSUMED BY THE FUNCTIONS

Function	Quadrant I		Quadrant II		Quadrant III		Quadrant IV	
	Sign	Value	Sign	Value	Sign	Value	Sign	Value
sin.....	+	0 to 1	+	1 to 0	-	0 to 1	-	1 to 0
cos.....	+	1 to 0	-	0 to 1	-	1 to 0	+	0 to 1
tan.....	+	0 to ∞	-	∞ to 0	+	0 to ∞	-	∞ to 0
cot.....	+	∞ to 0	-	0 to ∞	+	∞ to 0	-	0 to ∞
sec.....	+	1 to ∞	-	∞ to 1	-	1 to ∞	+	∞ to 1
cosec.....	+	∞ to 1	+	1 to ∞	-	∞ to 1	-	1 to ∞

TRIGONOMETRY

VALUE OF THE FUNCTIONS OF VARIOUS ANGLES

	0°	30°	45°	60°	90°	180°	270°
sin.....	0	$\frac{1}{2}$	$\frac{1}{\sqrt{2}}$	$\frac{\sqrt{3}}{2}$	1	0	-1
cos.....	1	$\frac{\sqrt{3}}{2}$	$\frac{1}{\sqrt{2}}$	$\frac{1}{2}$	0	-1	0
tan.....	0	$\frac{1}{\sqrt{3}}$	1	$\sqrt{3}$	∞	0	∞
cot.....	∞	$\sqrt{3}$	1	$\frac{1}{\sqrt{3}}$	0	∞	0
sec.....	1	$\frac{2}{\sqrt{3}}$	$\sqrt{2}$	2	∞	-1	∞
cosec.....	∞	2	$\sqrt{2}$	$\frac{2\sqrt{3}}{3}$	1	∞	-1

EXPONENTIAL DEFINITIONS OF CIRCULAR FUNCTIONS

$$\begin{aligned} \sin x &= \frac{1}{2i} (e^{ix} - e^{-ix}) & \text{cosec } x &= \frac{2i}{e^{ix} - e^{-ix}} \\ (i^2 &= -1) \\ \cos x &= \frac{e^{ix} + e^{-ix}}{2} & \sec x &= \frac{2}{e^{ix} + e^{-ix}} \\ \tan x &= \frac{e^{ix} - e^{-ix}}{ie^{ix} + ie^{-ix}} & \cot x &= \frac{ie^{ix} + ie^{-ix}}{e^{ix} - e^{-ix}} \end{aligned}$$

RELATIONS OF THE FUNCTIONS

$$\begin{aligned} \sin x &= \frac{1}{\text{cosec } x} & \text{cosec } x &= \frac{1}{\sin x} \\ \cos x &= \frac{1}{\sec x} & \sec x &= \frac{1}{\cos x} \\ \tan x &= \frac{\sin x}{\cos x} & \sin^2 x + \cos^2 x &= 1. \\ \cot x &= \frac{\cos x}{\sin x} & 1 + \tan^2 x &= \sec^2 x. \\ * \sin x &= \pm \sqrt{1 - \cos^2 x} & 1 + \cot^2 x &= \text{cosec}^2 x. \\ * \tan x &= \pm \sqrt{\sec^2 x - 1} & * \cos x &= \pm \sqrt{1 - \sin^2 x}. \\ * \cot x &= \pm \sqrt{\text{cosec}^2 x - 1} & * \sec x &= \pm \sqrt{\tan^2 x + 1}. \\ \sin x &= \cos (90^\circ - x) = \sin (180^\circ - x). & * \text{cosec } x &= \pm \sqrt{\cot^2 x + 1}. \\ \cos x &= \sin (90^\circ - x) = -\cos (180^\circ - x). \\ \tan x &= \cot (90^\circ - x) = -\tan (180^\circ - x). \\ \cot x &= \tan (90^\circ - x) = -\cot (180^\circ - x). \\ \text{cosec } x &= \cot \frac{x}{2} - \cot x. \end{aligned}$$

* The sign in front of radical depends on quadrant in which x falls.

TRIGONOMETRY

FUNCTIONS OF SUMS OF ANGLES

$$\sin (x \pm y) = \sin x \cos y \pm \cos x \sin y.$$

$$\cos (x \pm y) = \cos x \cos y \mp \sin x \sin y.$$

$$\tan (x \pm y) = \frac{\tan x \pm \tan y}{1 \mp \tan x \tan y}.$$

FUNCTIONS OF MULTIPLE ANGLES

$$\sin 2x = 2 \sin x \cos x.$$

$$\cos 2x = \cos^2 x - \sin^2 x = 2 \cos^2 x - 1 = 1 - 2 \sin^2 x.$$

$$\sin 3x = 3 \sin x - 4 \sin^3 x.$$

$$\cos 3x = 4 \cos^3 x - 3 \cos x.$$

$$\sin 4x = 8 \cos^3 x \sin x - 4 \cos x \sin x.$$

$$\cos 4x = 8 \cos^4 x - 8 \cos^2 x + 1.$$

$$\sin 5x = 5 \sin x - 20 \sin^3 x + 16 \sin^5 x.$$

$$\cos 5x = 16 \cos^5 x - 20 \cos^3 x + 5 \cos x.$$

$$\sin 6x = 32 \cos^5 x \sin x - 32 \cos^3 x \sin x + 6 \cos x \sin x.$$

$$\cos 6x = 32 \cos^6 x - 48 \cos^4 x + 18 \cos^2 x - 1.$$

$$\tan 2x = \frac{2 \tan x}{1 - \tan^2 x}.$$

$$\cot 2x = \frac{\cot^2 x - 1}{2 \cot x}.$$

$$\tan 3x = \frac{3 \tan x - \tan^3 x}{1 - 3 \tan^2 x}.$$

$$*\sin \frac{1}{2}x = \pm \sqrt{\frac{1 - \cos x}{2}}.$$

$$*\cos \frac{1}{2}x = \pm \sqrt{\frac{1 + \cos x}{2}}.$$

$$*\tan \frac{1}{2}x = \pm \sqrt{\frac{1 - \cos x}{1 + \cos x}} = \frac{1 - \cos x}{\sin x} = \frac{\sin x}{1 + \cos x}.$$

* The sign in front of radical depends on quadrant in which x falls.

TRIGONOMETRY

MISCELLANEOUS RELATIONS

$$\sin x \pm \sin y = 2 \sin \frac{1}{2}(x \pm y) \cdot \cos \frac{1}{2}(x \mp y).$$

$$\cos x + \cos y = 2 \cos \frac{1}{2}(x + y) \cdot \cos \frac{1}{2}(x - y).$$

$$\cos x - \cos y = -2 \sin \frac{1}{2}(x + y) \cdot \sin \frac{1}{2}(x - y).$$

$$\sin x \cos y = \frac{1}{2}[\sin (x + y) + \sin (x - y)]$$

$$\cos x \sin y = \frac{1}{2}[\sin (x + y) - \sin (x - y)]$$

$$\cos x \cos y = \frac{1}{2}[\cos (x + y) + \cos (x - y)]$$

$$\sin x \sin y = \frac{1}{2}[\cos (x - y) - \cos (x + y)]$$

$$\tan x \pm \tan y = \frac{\sin (x \pm y)}{\cos x \cdot \cos y}, \quad \cot x \pm \cot y = \frac{\pm \sin (x \pm y)}{\sin x \cdot \sin y}.$$

$$1 + \tan x = \tan (45^\circ + x), \quad \frac{\cot x + 1}{1 - \tan x} = \cot (45^\circ - x).$$

$$\frac{\sin x \pm \sin y}{\cos x \pm \cos y} = \tan \frac{1}{2}(x \pm y).$$

$$\frac{\sin x \pm \sin y}{\sin x \pm \sin y} = -\cot \frac{1}{2}(x \mp y).$$

$$\frac{\sin x - \sin y}{\sin x + \sin y} = \frac{\tan \frac{1}{2}(x + y)}{\tan \frac{1}{2}(x - y)}.$$

$$\sin^2 x - \sin^2 y = \sin (x + y) \cdot \sin (x - y).$$

$$\cos^2 x - \cos^2 y = -\sin (x + y) \sin (x - y).$$

$$\cos^2 x - \sin^2 y = \cos (x + y) \cos (x - y).$$

INVERSE TRIGONOMETRIC FUNCTIONS

The following table lists each of the six inverse trigonometric functions together with the interval of its principal value:

Function	Interval containing principal value	
	x positive or zero	x negative
$y = \sin^{-1} x$ and $\tan^{-1} x$	$0 \leq y \leq \pi/2$	$-\pi/2 \leq y < 0$
$y = \cos^{-1} x$ and $\cot^{-1} x$	$0 \leq y \leq \pi/2$	$\pi/2 < y \leq \pi$
$y = \sec^{-1} x$ and $\csc^{-1} x$	$0 \leq y \leq \pi/2$	$-\pi \leq y \leq -\pi/2$

Usually the first letter in "arc" or the name of the inverse trigonometric functions is capitalized if the principal value is desired. Thus

$$\text{Arc sin } \frac{1}{2} = \text{Sin}^{-1} \frac{1}{2} = \frac{\pi}{6},$$

$$\text{while } \text{arc sin } \frac{1}{2} = \frac{\pi}{6} + 2\pi n \text{ or } \frac{5\pi}{6} + 2\pi n$$

In the calculus both for differentiation or integral formulas, capitalization is not adhered to strictly, but principal values are always understood for inverse trigonometric functions when used unless specifically stated otherwise.

TRIGONOMETRY

RELATIONS BETWEEN SIDES AND ANGLES OF ANY PLANE TRIANGLE

In a triangle with angles $A, B,$ and C and sides opposite $a, b,$ and c respectively,

$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C} = \text{diameter of the circumscribed circle.}$$

$$a^2 = b^2 + c^2 - 2bc \cos A.$$

$$a = b \cos C + c \cos B.$$

$$\cos A = \frac{b^2 + c^2 - a^2}{2bc}.$$

$$\tan \frac{A-B}{2} = \frac{a-b}{a+b} \cot \frac{C}{2}.$$

$$\sin A = \frac{2}{bc} \sqrt{s(s-a)(s-b)(s-c)},$$

$$\text{where } s = \frac{1}{2}(a+b+c) \text{ and } r = \sqrt{\frac{(s-a)(s-b)(s-c)}{s}}.$$

$$\sin \frac{A}{2} = \sqrt{\frac{(s-b)(s-c)}{bc}}.$$

$$\cos \frac{A}{2} = \sqrt{\frac{s(s-a)}{bc}}.$$

$$\tan \frac{A}{2} = \sqrt{\frac{(s-b)(s-c)}{s(s-a)}} = \frac{r}{s-a}.$$

$$\frac{a+b}{a-b} = \frac{\sin A + \sin B}{\sin A - \sin B} = \frac{\tan \frac{1}{2}(A+B)}{\tan \frac{1}{2}(A-B)} = \frac{\cot \frac{1}{2}C}{\tan \frac{1}{2}(A-B)}.$$

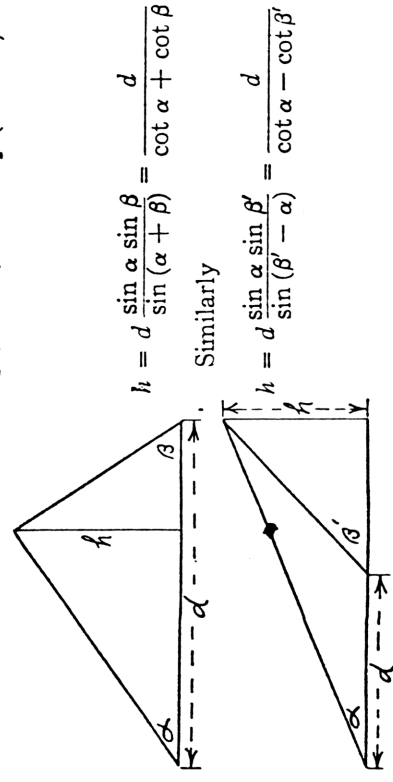


Fig. 5

TRIGONOMETRY

RELATIONS IN ANY SPHERICAL TRIANGLE

If A, B and C be the three angles and $a, b,$ and c the opposite sides,

$$\frac{\sin A}{\sin a} = \frac{\sin B}{\sin b} = \frac{\sin C}{\sin c}.$$

$$\cos a = \cos b \cos c + \sin b \sin c \cos A = \frac{\cos b \cos (c \pm \theta)}{\cos \theta}.$$

$$\text{where } \tan \theta = \tan b \cos A.$$

$$\cos A = -\cos B \cos C + \sin B \sin C \cos a.$$

$$\sin \frac{1}{2}A = \sqrt{\frac{\sin(s-b) \sin(s-c)}{\sin b \sin c}}.$$

$$\text{where } s = \frac{1}{2}(a+b+c).$$

$$\cos \frac{1}{2}A = \sqrt{\frac{\sin s \sin(s-a)}{\sin b \sin c}}.$$

$$\tan \frac{1}{2}A = \frac{\sin(s-a)}{\sin(s-b) \sin(s-c)} \sin s.$$

$$\text{where } r = \frac{\sin s}{\sin(s-b) \sin(s-c)}.$$

$$\cos \frac{1}{2}a = \sqrt{\frac{\cos(S-B) \cos(S-C)}{\sin B \sin C}}.$$

$$\text{where } S = \frac{1}{2}(A+B+C).$$

$$\sin \frac{1}{2}a = \sqrt{\frac{\cos S \cos(S-A)}{\sin B \sin C}}.$$

$$\tan \frac{1}{2}a = R \cos(S-A)$$

$$\text{where } R = \frac{-\cos S}{\cos(S-A) \cos(S-B) \cos(S-C)}.$$

$$\tan \frac{a+b}{2} = \frac{\cos \frac{A-B}{2} \tan \frac{A+B}{2}}{\cos \frac{C}{2}} = \frac{\frac{a-b}{\cos \frac{a-b}{2}}}{\cos \frac{a+b}{2}}.$$

$$\tan \frac{c}{2} = \frac{\cot \frac{C}{2}}{\cot \frac{A+B}{2}} = \frac{\frac{a-b}{\sin \frac{a-b}{2}}}{\sin \frac{a+b}{2}}.$$

$$\tan \frac{a-b}{2} = \frac{\sin \frac{A-B}{2}}{\sin \frac{A+B}{2}} = \frac{\frac{a-b}{\sin \frac{a-b}{2}}}{\sin \frac{a+b}{2}}.$$

$$\tan \frac{c}{2} = \frac{\cot \frac{C}{2}}{\cot \frac{A+B}{2}} = \frac{\frac{a-b}{\sin \frac{a-b}{2}}}{\sin \frac{a+b}{2}}.$$

$$\text{hav } a = \text{hav}(b-c) + \sin b \sin c \text{ hav } A.$$

$$\text{hav } A = \frac{\sqrt{\text{hav}[a+(b-c)] \text{hav}[a-(b-c)]}}{\sin b \sin c}.$$

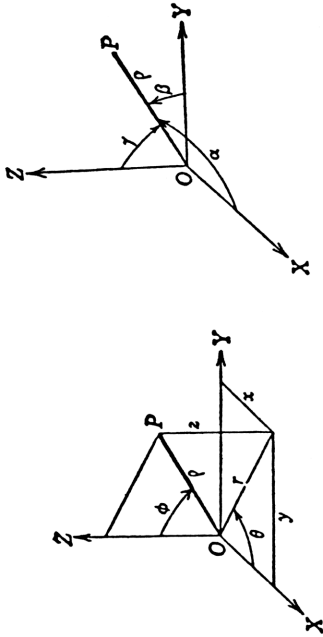
ANALYTICAL GEOMETRY

TRANSFORMATION OF COORDINATES (Continued)

SOLID ANALYTICAL GEOMETRY

Space Coordinates

1. Rectangular System x, y, z .
2. Cylindrical System r, θ, z .
3. Spherical System ρ, θ, ϕ . In certain situations it is desirable to interchange the symbols ϕ for θ and vice versa.
4. Polar Space System $\rho, \alpha, \beta, \gamma$.



Relations of Coordinates of Systems in Terms of x, y, z		
Cylindrical	Spherical	Polar Space
$r = \sqrt{x^2 + y^2}$	$\rho = \sqrt{x^2 + y^2 + z^2}$	$\rho = \sqrt{x^2 + y^2 + z^2}$
$\theta = \tan^{-1} \frac{y}{x}$	$\theta = \tan^{-1} \frac{y}{x}$	$\alpha = \cos^{-1} \left(\frac{x}{\sqrt{x^2 + y^2 + z^2}} \right)$
$z = z$	$\phi = \cos^{-1} \left(\frac{z}{\sqrt{x^2 + y^2 + z^2}} \right)$	$\beta = \cos^{-1} \left(\frac{y}{\sqrt{x^2 + y^2 + z^2}} \right)$
		$\gamma = \cos^{-1} \left(\frac{z}{\sqrt{x^2 + y^2 + z^2}} \right)$

Relations of Rectangular Coordinates (x, y, z) in Terms of Cylindrical, Spherical and Polar Space Coordinates		
Cylindrical	Spherical	Polar Space
$x = r \cos \theta$ $y = r \sin \theta$ $z = z$	$x = \rho \sin \phi \cos \theta$ $y = \rho \sin \phi \sin \theta$ $z = \rho \cos \phi$	$x = \rho \cos \alpha$ $y = \rho \cos \beta$ $z = \rho \cos \gamma$

ANALYTICAL GEOMETRY

TRANSFORMATION OF COORDINATES

Rectangular System

- (1) Translation only of axes parallel to themselves.
The coordinates of new origin with respect to old axes: $x = h, y = k$. Primed letters designate new coordinates.

$$\begin{array}{lll} x' = x - h & x = x' + h \\ y' = y - k & y = y' + k \end{array}$$

- (2) Rotation of axes with fixed origin.

Angle of rotation = θ

$$\begin{array}{lll} x' = x \cos \theta + y \sin \theta & x = x' \cos \theta - y' \sin \theta \\ y' = y \cos \theta - x \sin \theta & y = y' \cos \theta + x' \sin \theta \end{array}$$

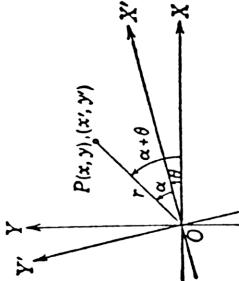
- (3) Origin translated and axes rotated.
Symbols same as above

$$\begin{array}{lll} x' = (x - h) \cos \theta + (y - k) \sin \theta \\ y' = (y - k) \cos \theta - (x - h) \sin \theta \\ x = x' \cos \theta - y' \sin \theta + h \\ y = y' \cos \theta + x' \sin \theta + k \end{array}$$

Relation between Rectangular and Polar Coordinates

$$\begin{array}{lll} x = r \cos \theta & r = \sqrt{x^2 + y^2} & \sin \theta = \frac{y}{\sqrt{x^2 + y^2}} \\ y = r \sin \theta & \theta = \tan^{-1} \frac{y}{x} & \cos \theta = \frac{x}{\sqrt{x^2 + y^2}} \end{array}$$

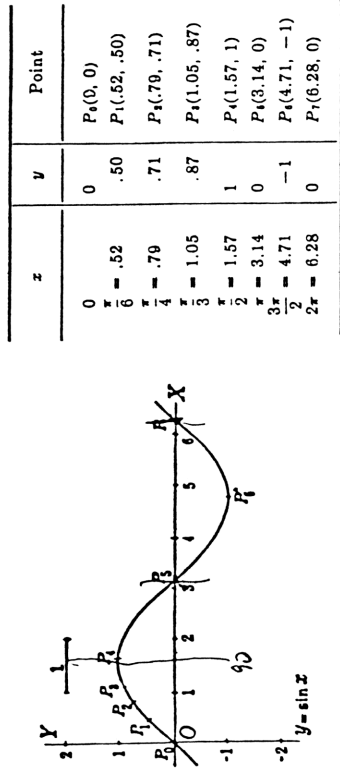
Rotation of Polar Axes through Angle θ



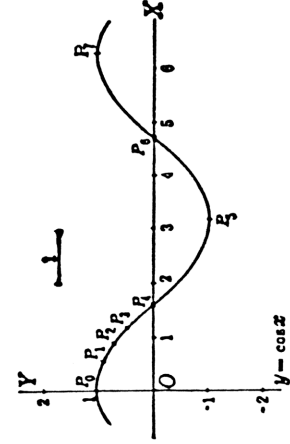
$$\begin{array}{ll} x' = r \cos \alpha \\ y' = r \sin \alpha \\ x = r \cos (\alpha + \theta) \\ y = r \sin (\alpha + \theta) \end{array}$$

TRIGONOMETRY

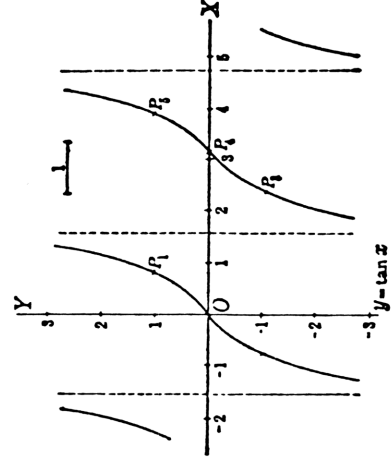
GRAPHS OF THE TRIGONOMETRIC FUNCTIONS



x	y	Point
0	1	$P_0(0, 1)$
$\frac{\pi}{6} = .52$	.87	$P_1(.52, .87)$
$\frac{\pi}{4} = .79$	.71	$P_2(.79, .71)$
$\frac{\pi}{2} = 1.05$	.5	$P_3(1.05, .5)$
$\frac{3\pi}{4} = 1.57$	0	$P_4(1.57, 0)$
$\frac{\pi}{2} = 3.14$	-1	$P_5(3.14, -1)$
$\frac{3\pi}{2} = 4.71$	0	$P_6(4.71, 0)$
$2\pi = 6.28$	1	$P_7(6.28, 1)$



x	y	Point
0	0	$P_0(0, 0)$
$\frac{\pi}{4} = .79$	1	$P_1(.79, 1)$
$\frac{\pi}{2} = 1.05$	∞	
$\frac{3\pi}{4} = 1.57$	-1	$P_2(1.57, -1)$
$\frac{5\pi}{4} = 3.93$	0	$P_3(3.93, 0)$
$\frac{3\pi}{2} = 4.71$	1	$P_4(4.71, 1)$
$2\pi = 6.28$	∞	
	0	$P_5(6.28, 0)$



TRIGONOMETRY

GRAPHS OF THE TRIGONOMETRIC FUNCTIONS

