BASIC PROGRAMS AND EQUATIONS IN HP 33s FOR PE CIVIL SURVEYING EXAM

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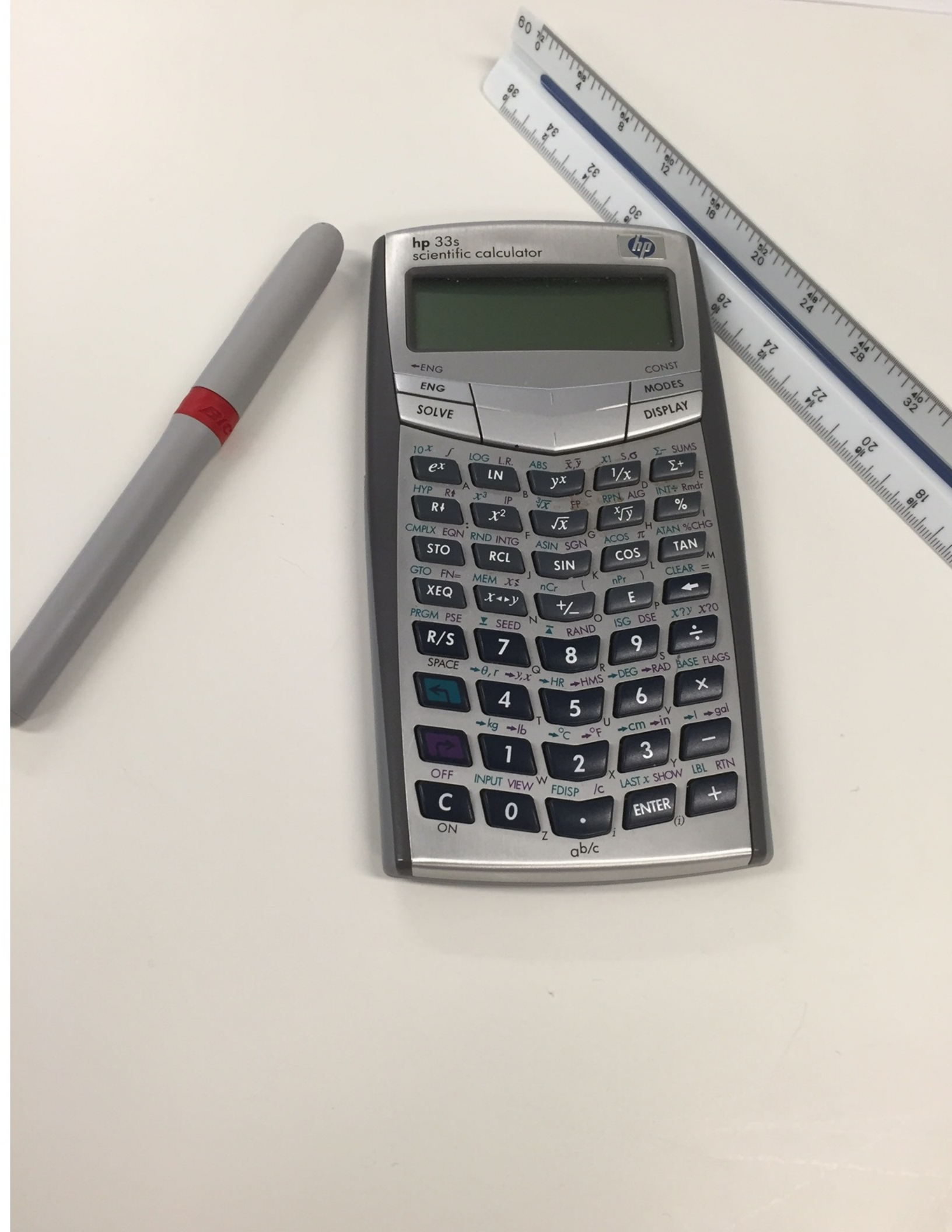
hp 33s
scientific calculator
ENG
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ABOUT THE AUTHOR

Joselito Intia de Paula was born in Centro, Oas, Albay, Philippines, son of Cesar and Corazon de Paula and finished his college degree at Bicol University, College of Engineering, Legazpi City with a degree of Bachelor of Science in Civil Engineering in the year 1992. On the same year where he finished his college degree at the age of 21 he passed the Board Examination for Civil Engineering and Geodetic Engineering in the Philippines.

He works abroad for 8 years in the Middle East as a Survey/Site Engineer in various foreign European companies such as ABV Rock Group, Norconsult Telematics, and Archirodon Construction Company.

He and his family immigrated to the United States in the state of California in the year of 2006. After a month of his arrival in the United States he landed a job in Mark Thomas and Company, a Transportation Engineering Consulting firm at Walnut Creek, California. He passed the Engineer-in-Training (EIT) examination of the Board of Professional Engineers and Land Surveyors and Geologist (BPELSG). He later joined the San Francisco Public Utilities Commission – Engineering Management Bureau year 2012 up to present.

He has two sons named Cesar Henry, 13 years old and Andrei Joselito, a new born whose birth was around the time of this book's creation. His wife Elizabeth Morante is a Registered Nurse who works as an Operating Room Nurse in the Contra Costa Regional Medical Center in Martinez, Ca. USA.

Joselito loves to play golf and tennis.

PREFACE

THE CONTENTS OF THIS BOOK ARE PROVIDED TO GUIDE THE USER OF HP 33s ON HOW TO STORE SURVEY EQUATIONS AND PROGRAMS AND HOW TO SAVE TIME IN SOLVING PROBLEMS THAT HAVE LENGTHY SOLUTIONS BY HAVING THIS KIND OF TOOL. THIS HP33s IS INCLUDED IN THE LIST OF OFFICIAL CALCULATORS ALLOWED DURING THE TEST.

IN REGARDS TO THE PROBLEMS THAT NEED MORE TIME TO SOLVE , IT IS BETTER TO ANTICIPATE THOSE SURVEY PROGRAMS AND EQUATIONS AND STORE THEM IN THE CALCULATOR BEFOREHAND. AN EXAMPLE OF A PROBLEM THAT MIGHT NEED A FEW MORE MINUTES TO SOLVE IS ONE OF CALCULATING AN AREA BY COORDINATE METHOD OR DETERMINING AN AREA USING DOUBLE MERIDIAN DISTANCE (DMD) METHOD.

IN THIS BOOK YOU WILL FIND THOSE EQUATIONS AND PROGRAMS THAT CAN HELP YOU SAVE TIME IN SOLVING A PROBLEM THAT HAS A LONG SOLUTION.

I HOPE YOU FIND THIS BOOK A USEFULL TOOL TO PASS THE PE CIVIL SURVEYING EXAM.

ACKNOWLEDGEMENT

I WOULD LIKE TO THANK GOD FOR GIVING ME THE STRENGTH AND WISDOM TO REALIZE THIS BOOK; TO MY FAMILY WHO SERVES AS MY INSPIRATION, ESPECIALLY MY TWO SONS NAMED CESAR HENRY AND ANDREI JOSELITO AND MY LOVING WIFE ELIZABETH WHO GAVE ME A LOT OF SUPPORT IN EVERYTHING.

INTRODUCTION:

THE CONTENTS OF THIS BOOK EXPLAIN HOW TO STORE BASIC PROGRAMS AND EQUATIONS FOR SURVEYING IN HP33s. THIS BOOK WILL GIVE YOU CONSTANT PRACTICE USING A CALCULATOR'S PROGRAM MODE OR EQUATION MODE AND SOLVE FUNCTIONS. YOU CAN SAVE A LOT OF TIME BY USING THIS APPROVED CALCULATOR OF NCCS DURING THE TEST FOR PE CIVIL SURVEYING EXAM.

THE BOOK CONTAINS THREE PARTS, NAMELY "LIST OF SURVEY EQUATIONS", "LIST OF SURVEY PROBLEMS", AND "SAMPLE PROBLEMS." ALSO, THERE ARE MORE THAN THIRTY STORED BASIC SURVEY EQUATIONS ON THIS CALCULATOR. YOU MAY REFER TO HP33s HANDBOOK MANUAL FOR QUICK AND EASY STORING OF THOSE EQUATIONS. YOU SHOULD FAMILIARISE YOURSELF WITH THE VERY BASIC METHOD OF USING THE CALCULATOR IN REVERSE POLISH NOTATION (RPN). ALL THE BASIC PROGRAMS AND EQUATIONS USED HEREIN ARE IN RPN MODE. IF YOU HAVE ANY QUESTIONS OR CONCERNS YOU MAY EMAIL ME AT lito.pau@gmail.com

REFERENCES:

CALTRANS, “SAMPLE PROBLEMS FOR BASIC SURVEYING MATH”

HEWLETT PACKARD COMPANY, “HANDBOOK MANUAL FOR HP33s CALCULATOR”

VENANCIO I. BESAVILLA, “SURVEYING FORMULAS FOR COMPUTERIZED LICENSURE EXAMS”

DISCLAIMER:

THE HEWLETT-PACKARD COMPANY AND ITS AFFILIATES ARE IN NO WAY INVOLVED WITH THIS BOOK. THE CALCULATOR IS ONLY A TOOL FOR YOU TO SAVE TIME IN SOLVING LENGTHY PROBLEMS ON THE PE CIVIL SURVEYING EXAM. PASSING THIS TEST WILL DEPEND ON THE EFFORTS OF EACH INDIVIDUAL TAKING THE TEST, AND ARE NOT THE RESPONSIBILITY OF THE AUTHOR.

LIST OF SURVEY EQUATIONS

LIST OF USEFUL SURVEY EQUATIONS

I-TAPE CORRECTION

SLOPE EQUATION

$H = L\cos\alpha$

WHERE:

A = ANGLE α
L = SLOPE DIST.
H = HORIZONTAL DIST.

1 **EQ001SLOPE** **H = L x cosA**

2- TEMPERATURE

$C = 6.45 \times 10^{-6} (T - T_S)L$

where:
C = CORRECTION
A = T_S (STD TEMP. @ 68° F)
T = GIVEN TEMP.
L = MEASURED DIST.

2 **EQ002TEMP** **C=(6.45 x 10-6)x(T – A)xL**

3 - PULL CORRECTIONS

$C_P = [(P_1 - P_S)/AE]L$

where:
C = CP, CORRECTION
A = A, CROSS SECTIONAL ARE OF THE TAPE
E = E, MODULUS OF ELASTICITY OF THE STEEL TAPE
X = P1, APPLIED PULL
Y = PS, STANDARD PULL
L = L, MEASURED DISTANCE

3 **EQ003PULL** **C = ((X - Y) ÷ (A x E)) x L**

4 - SAG CORRECTION:

$C = - (W\text{^}2)LS \div 24P_1^2$

where:
C = CS, SAG CORRECTION
W = W, TOTAL WEIGHT OF STEEL TAPE
P = P1, APPLIED PULL
L = LS, UNSUPPORTED TAPE LENGTH

4 **EQ004SAG** **C= -((W^2)xL)÷((24)x(P^2))**

B – LEVELLING

i) DIFFERENTIAL LEVELLING

ELEVATION @ ANY POINT = INITIAL EL. + (ΣBS –ΣFS)

Where:
E = ELEV. @ ANY POINT
I = INITIAL ELEV.
B = ΣBS, SUM OF ALL THE BACKSIGHT
F = ΣFS, SUM OF ALL THE FORESIGHT

5 **EQ005LEVELLING** **E = I+(B - F)**

HI = ELEV. BENCHMARK + BACKSIGHT

Where:
H =HI, HEIGHT OF INSTRUMENT
E = BM, BENCHMARK ELEVATION (KNOWN)
B = BS, BACKSIGHT
F = FS, FORESIGHT
U = UNKNOWN ELEV.

6 **EQ006HI** **H = E +B**

7 **EQ007UNKELEV** **U = H – F**

MISCLOSURE = OBSERVED EL. – ESTABLISHED EL.

where:
M = MISCLOSURE DIFFERENCE
O = OBSERVED EL.
E = ESTABLISHED EL.

8 **EQ008MISCLOSURE** **M = O – E**

CORRECTION = MISCLOSURE/No. of SETUPS x CUMULATIVE No. of SETUPS

where:
C = CORRECTION TO EACH PT.
M = MISCLOSURE
N = No. of SET-UPS
Z = CUMULATIVE

9 **EQ009CORRMISC** **C = (M ÷ N) x Z**

C – STADIA

where:
S = S, NORMALIZED ROD INTERVAL
T = S, ROD INTERVAL
D = D, DISTANCE LINE OF SIGHT

H = H, HORIZONTAL DIST.
V = V, VERTICSL CURVE
A = ANGLE, Θ

S = S'COSΘ

10 **EQ010RODINTERVAl** **S=TxCOS(A)**

11 **EQ011DISTLOS** **D=100xTxCOS(A)**

12 **EQ012HORDIST** **H=100xTx(COS(A))^2**

13 **EQ013VERTDIST** **V=100xTxCOS(A)XSIN(A)**

D - SLOPE

S =((ELEV.B - ELEV.A)÷(STA.B - STA.A))x100

WHERE:
S = SLOPE IN %
A = ELEV. A
Y = STA. A
B = ELEV. B
X = STA. B

14 **EQ014SLOPE** **S=((B-A)÷(X-Y))x100**

E - AREAS

P = √S(S-A)(S-B)(S-C)

WHERE:
P = AREA OF A 3 GIVEN SIDES

15 **EQ015SIDES** **S = (A+B+C)÷2**

16 **EQ016AREA3SIDES** **P=SQ.RT√Sx(S-A)x(S-B)X(S-C)**

17 **EQ017AREASAS** **P=0.5xAxBxSIN(X)**
WHERE:
P = AREA
A = SIDE
B = SIDE
X = INCLUDED ANGLE

18 **EQ018COSLAW** **A=SQ.RT(B^2+C^2)-2xBxCxCOS(X)**

WHERE:
A = SIDE
B = SIDE
C = SIDE
X = INCLUDED ANGLE

F - HORIZONTAL CURVES

FORMULAS:

T = R TAN (I/2)
WHERE:
T = TANGENT
R = RADIUS
I = CENTRAL ANGLE

19 **EQ019TAN** **T=RxTAN(I÷2)**

L = R I (∏) / 180
WHERE:
L = LENGTH OF CURVE
R = RADIUS
I = CENTRAL ANGLE

20 **EQ020LCURVE** **L = Rx Ix (∏)÷ 180**

LC = 2RSIN(I/2)
WHERE:
C = LC, LONG CHORD
R = RADIUS
I = CENTRAL ANGLE

21 **EQ021LONGCHORD** **C = 2xRxSIN(I÷2)**

M = R(1-COS (I/2)
WHERE:
M = MIDDLE ORDINATE
R = RADIUS
I = CENTRAL ANGLE

22 **EQ022MIDORD** **M=Rx(1-COS (I÷2)**

E=R((1÷COS(I÷2))-1)
WHERE:
E = EXTERNAL DISTANCE
R = RADIUS
I = CENTRAL ANGLE

23 **EQ023EXTDIST** **E=Rx((1÷COS(I÷2))-1)**

G - DEFLECTION ANGLE METHOD

FORMULAS:

D = (I÷L)x£
WHERE:
D = SUB-CENTRAL ANGLE
L = LENGTH OF CURVE

I = CENTRAL ANGLE
F = £, SUB-LENGTH OF CURVE

24	**EQ024DEFANGME**	**D = (I÷L)x£**

NOTE:
IN PLUGGING IN THE VALUES OF THE GIVEN CENTRAL ANGLE IN HP33s CALCULATOR IT MUST BE CONVERTED FROM DEGREES TO RADIANS.

EX. 65DEG 45'35"
KEY

65.4535	DEGREES
←┐ →HR	
65.7597	RADIANS

H - VERTICAL CURVES

SYMBOLS:
G = G1 IN %
H = G2 IN %
L = L, LENGTH OF VERTICAL CURVE

RESULTS:
R = RATE OF CHANGE
X = HIGH OR LOW POINT LOCATION FROM BVC
M = MIDDLE ORDINATE

SYMBOLS:
B = BVC STATION
C = BVC ELEVATION
D = DISTANCE FROM BVC

RESULTS:
Y = ELEVATION AT ANY POINT AT DIST. D
S = SLOPE AT ANY POINT AT DIST. D
O = OFFSET FROM GRADE LINE TO CURVE
Z = ELEVATION OF HIGH OR LOW POINT
I = STATION OF HIGH OR LOW POINT

25	**EQ025RATEOFCH**	**R= (G-H)÷L**
26	**EQ026HILO**	**X= (GxL)÷(G-H)**
27	**EQ027MIDORD**	**M= ((G-H)xL)÷ABS(G-H)**
28	**EQ028ELEVANYPTD**	**Y= C+(GxD)+(0.5xRxD^2)**
29	**EQ029ELEVANYPTX**	**Z= C+(GxX)+(0.5xRxX^2)**

30 **EQ030SLOPEANYPT** **S= ((GxL)-(Dx(G-H)))÷L**

31 **EQ031OFFSET** **O= (4xMxD^2)÷L^2**

EXAMPLE OF HOW TO INPUT SURVEY EQUATIONS INTO HP33s.

31 **EQ031OFFSET** **O= (4xMxD^2)÷L^2**

FIRST SEE TO IT THAT YOUR CALCULATOR IS IN RPN (REVERSE POLISH NOTATION) MODE

GB	GREEN BUTTON
PB	PURPLE BUTTON

START

GB
RPN
PB
EQN
RCL E
RCL Q
31
RCL O
RCL F
RCL F
RCL S
RCL E
RCL T
ENTER
RCL O
=
(4xMxD^2)÷L^2
ENTER

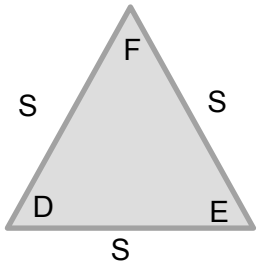
LIST OF SURVEY PROGRAMS

TRIGONOMETRY INVOLVING ELEMENTS OF TRIANGLES

TRIGONOMETRY

GENERAL SYMBOLS USED FOR THE ELEMENTS OF A TRIANGLE

FIGURE 1.0



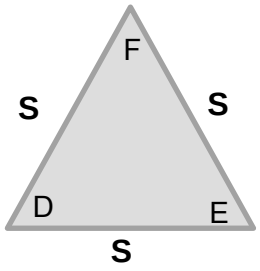
S = SIDE
S = SIDE
S = SIDE
D = ANGLE
E = ANGLE
F = ANGLE

NOTE:

THE FIGURE 1.0 ONLY APPLIES TO THE FOLLOWING PROGRAM:

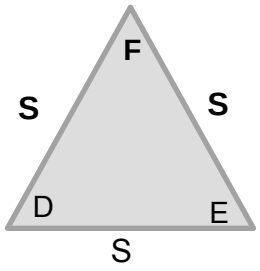
```
1 XEQ A - SIDE SIDE SIDE
2 XEQ B - SIDE ANGLE SIDE
3 XEQ C - SIDE SIDE ANGLE
4 XEQ D - ANGLE ANGLE SIDE
5 XEQ E - ANGLE SIDE ANGLE
```

1 **SIDE SIDE SIDE**



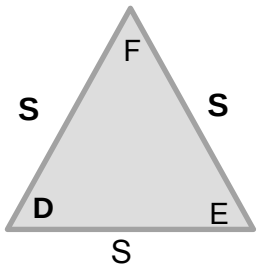
	XEQ A
A001	LBL A
A002	INPUT S
A003	STO A
A004	INPUT S
A005	STO B
A006	INPUT S
A007	STO C
A008	EQN ACOS ((A^2-B^2-C^2) ÷ (2 x B x Cx(-1)))
A009	→HMS
A010	STO D
A011	EQN ACOS ((A^2-B^2-C^2) ÷ (2 x A x C))
A012	→HMS
A013	STO E
A014	EQN ACOS ((C^2-A^2-B^2) ÷ (2 x A x B))
A015	→HMS
A016	STO F
A017	→HR
A018	STO Z
A019	EQN 0.5 x A x B x sin(z)
A020	STO G
A021	43560
A022	÷
A023	STO H
A024	VIEW D
A025	VIEW E
A026	VIEW F
A027	VIEW G
A028	VIEW H
A029	R/S
A030	GTO A
A031	RTN

2 **SIDE ANGLE SIDE**



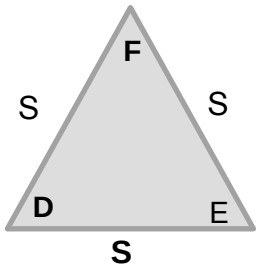
	XEQ B
B001	LBL B
B002	INPUT S
B003	STO L
B004	INPUT A
B005	STO F
B006	INPUT S
B007	STO B
B008	RCL F
B009	→HR
B010	STO Z
B011	EQN SQRT((L^2+B^2) - (2 x L x B x cos(z)))
B012	STO C
B013	EQN Asin[(L x sin(z)) ÷ C]
B014	→HMS
B015	STO D
B016	EQN Asin[(B x sin(z)) ÷ C]
B017	→HMS
B018	STO E
B019	EQN 0.5 x L x B x sin(z)
B020	STO G
B021	43560
B022	÷
B023	STO H
B024	VIEW D
B025	RCL C
B026	STO S
B027	VIEW S
B028	VIEW E
B029	VIEW G
B030	VIEW H
B031	R/S
B032	GTO B
B033	RTN

SIDE SIDE ANGLE



	XEQ C
C001	LBL C
C002	INPUT S
C003	STO A
C004	INPUT S
C005	STO B
C006	INPUT A
C007	STO D
C008	RCL D
C009	→HR
C010	STO Z
C011	EQN Asin((B x sinZ) ÷ A)
C012	→HMS
C013	STO E
C014	RCLE
C015	→HR
C016	STO Y
C017	EQN (180 - Z - Y)
C018	STO X
C019	EQN ((A^2+B^2)-(2xAxBxCOS(X)))
C020	STO C
C021	EQN 0.5 x A x B x sinX
C022	STO G
C023	43560
C024	÷
C025	STO H
C026	RCL X
C027	→HMS
C028	STO F
C029	RCL C
C030	STO S
C031	VIEW S
C032	VIEW E
C033	VIEW F
C034	VIEW G
C035	VIEW H
C036	R/S
C037	GTO C
C038	RTN

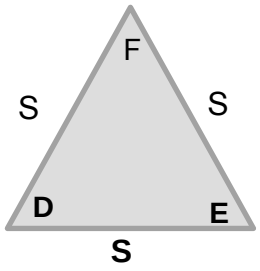
ANGLE ANGLE SIDE




```
                XEQ D
D001            LBL D
D002            INPUT A
D003            STO F
D004            INPUT A
D005            STO D
D006            INPUT S
D007            STO B
D008            RCL F
D009            →HR
D010            RCL D
D011            →HR
D012            +
D013            180
D014            -
D015            +/-
D016            →HMS
D017            STO E
D018            RCL D
D019            →HR
D020            STO Y
D021            RCL E
D022            →HR
D023            STO X
D024            RCL F
D025            →HR
D026            STO Z
D027            EQN (B x sinY) ÷ sinX
D028            STO L
D029            EQN (B x sinZ) ÷ sinX
D030            STO C
D031            EQN (0.5 x L xB x sinZ)
D032            STO G
D033            43560
D034            ÷
D035            STO H
D036            VIEW E
D037            RCL C
D038            STO S
D039            VIEW S
D040            RCL A
D041            STO S
D042            VIEW S
```

D043	VIEW G
D044	VIEW H
D045	R/S
D046	GTO D
D047	RTN

ANGLE SIDE ANGLE



	XEQ E
E001	LBL E
E002	INPUT A
E003	STO D
E004	INPUT S
E005	STO L
E006	INPUT A
E007	STO E
E008	RCL D
E009	→HR
E010	STO Y
E011	RCL E
E012	→HR
E013	STO X
E014	EQN (L x SIN(X)) ÷ SIN(Y)
E015	STO B
E016	EQN (180 - X - Y)
E017	STO Z
E018	EQN SQRT((L^2+B^2) - (2 x L x B x COS(Z)))
E019	STO C
E020	RCL Z
E021	→HMS
E022	STO F
E023	EQN (0.5 x A x B x sinZ)
E024	STO G
E025	43560
E026	÷
E027	STO H
E028	RCL C
E029	STO S
E030	VIEW S
E031	VIEW F
E032	RCL B
E033	STO S
E034	VIEW S
E035	VIEW G
E036	VIEW H
E037	R/S
E038	GTO E
E039	RTN

TRAVERSE

TRAVERSE

SYMBOLS:

N = NORTHING COORDINATES
E = EASTING COORDINATES
A = AZIMUTH
D = HORIZONTAL DISTANCE

	XEQ T
T001	LBL T
T002	INPUT N (BEGINNING NORTHING)
T003	INPUT E (BEGINNING EASTING)
T004	INPUT A (AZIMUTH)
T005	INPUT D (HORIZONTAL DISTANCE)
T006	RCL A
T007	→HR
T008	RCL D
T009	O, r -> y, x
T010	RCL + N
T011	STO N
T012	x <>y
T013	RCL + E
T014	STO E
T015	RCL X
T016	RCL E
T017	=
T018	RCL Y
T019	RCL N
T020	-
T021	y, x -> 0, r
T022	STOP
T023	x <> y
T024	180
T025	+
T026	→HMS
T027	STO Q
T028	RCL P
T029	RCL Q
T030	R/S (STOP)
T031	GTO T
T032	RTN

INVERSE

INVERSE

SYMBOLS:

N = NORTHING OCCUPIED
E = EASTING OCCUPIED
Y = NORTHING END
X = EASTING END

	XEQ I
I001	LBL I
I002	INPUT N
I003	INPUT E
I004	INPUT Y
I005	INPUT X
I006	RCL E
I007	RCL X
I008	-
I009	RCL N
I010	RCL Y
I011	-
I012	y,x →θ,r
I013	R/S (STOP)
I014	STO D
I015	x<>y
I016	180
I017	→HMS
I018	STO A
I019	VIEW D
I020	VIEW A
I021	R/S (STOP)
I022	GTO I
I023	RTN

AREA BY COORDINATE METHOD

AREA BY COORDINATES

SYMBOLS:

N = NORTHING
E = EASTING

	XEQ F
F001	LBL F
F002	CLVARS
F003	INPUT N
F004	STO Y
F005	STO C
F006	INPUT E
F007	STO X
F008	STOD
W001	LBL W
W002	INPUT N
W003	INPUT E
W004	RCL Y
W005	x
W006	RCL N
W007	RCL X
W008	x
W009	-
W010	RCL F
W011	+
W012	STO F
W013	RCL E
W014	RCL X
W015	-
W016	RCL N
W017	RCL Y
W018	-
W019	y,x →Θ,r
W020	RCL P
W021	+
W022	STO P
W023	RCL N
W024	STO Y
W025	RCL E
W026	STO X
W027	RCL D
W028	x≠y?
W029	GTO W
W030	RCL N
W031	RCL C
W032	x≠y?
W033	GTO W
W034	RCL P
W035	VIEW P
W036	RCL F
W037	2

W038	÷
W039	plus/minus sign
W040	STO F
W041	VIEW F
W042	43560
W043	÷
W044	STO A
W045	VIEW A
W046	RTN

AREA BY DOUBLE MERIDIAN DISTANCE (DMD) METHOD

AREA BY DMD METHOD

SYMBOLS:

A = BEARING OF LINE 1
B = HORIZONTAL DISTANCE OF LINE1
C = BEARING OF LINE 2
D = HORIZONTAL DISTANCE OF LINE 2
E = BEARING OF LINE 3
F = HORIZONTAL DISTANCE OF LINE 3
G = BEARING OF LINE 4
H = HORIZONTAL DISTANCE OF LINE 4
I = BEARING OF LINE 5
J = HORIZONTAL DISTANCE OF LINE 5

NOTE:

1 NORMALLY IN THE GIVEN PROBLEM OF A CLOSED POLYGON IS CONSIST OF 5 SIDES BUT IF IT IS LEES THAN 5 SIDES JUST MAKE THE BEARING AND DISTANCE OF THE LAST SIDES EQUALS TO ZERO WHEN INPUTING THE DATA INTO HP33s

2 CONVERT ALL THE BEARINGS INTO AZIMUTH
NE = ANGLE = AZIMUTH
SE = 180 - ANGLE
SW = 180 + ANGLE
NW = 360 - ANGLE

3
PLUGGING IN THE AZIMUTH IS THE SAME AS PLUGGING IN A NUMBER WITH A DECIMAL POINT.
EX.

AZIMUTH = 125º 35' 45"
HP 33s = 125.3545

RESULT:

Z = AREA IN SQUARE FEET (SQ.FT)
Q = AREA IN ACRES (AC)

BONUS RESULT:

A = DEPARTURE OF THE MISSING SIDE
B = LATITUDE OF THE MISSING SIDE
C = DISTANCE OF THE MISSING SIDE
D = ANGLE OF THE MISSING SIDE

HP 33s PROGRAM FOR DMD METHOD

```
        XEQ O
O001    LBL O
O002    INPUT A
O003    INPUT B
O004    RCL A
O005    →HR
O006    RCL B
O007    O, r --> y, x
```

```
O008    STO Y
O009    X < > Y
O010    STO X
O011    INPUT C
O012    INPUT D
O013    RCL C
O014    →HR
O015    RCL D
O016    O, r --> y, x
O017    STO W
O018    X < > Y
O019    STO V
O020    INPUT E
O021    INPUT F
O022    RCL E
O023    →HR
O024    RCL F
O025    O, r --> y, x
O026    STO S
O027    X < > Y
O028    STO U
O029    INPUT G
O030    INPUT H
O031    RCL G
O032    →HR
O033    RCL H
O034    O, r --> y, x
O035    STO T
O036    X < > Y
O037    STO R
O038    INPUT  I
O039    INPUT  J
O040    RCL  I
O041    →HR
O042    RCL  J
O043    O, r --> y, x
O044    STO O
O045    X < > Y
O046    STO P
O047    RCL  X
O048    2
O049    x
O050    RCL V
O051    +
O052    STO K
O053    RCL K
O054    RCL V
O055    +
O056    RCL U
O057    +
O058    STO L
O059    RCL L
O060    RCL U
O061    +
O062    RCL R
```

O063	+
O064	STO M
O065	RCL P
O066	+/-
O067	STO N
O068	RCL X
O069	RCL Y
O070	x
O071	RCL K
O072	RCL W
O073	x
O074	+
O075	RCL L
O076	RCL S
O077	x
O078	+
O079	RCL M
O080	RCL T
O081	x
O082	+
O083	RCL N
O084	RCL O
O085	x
O086	+
O087	2
O088	÷
O089	ABS
O090	STO Z
O091	VIEW Z
O092	RCL Z
O093	43,560
O094	÷
O095	ABS
O096	STO Q
O097	VIEW Q
O098	RCL X
O099	RCL V
O100	+
O101	RCL U
O102	+
O103	RCL R
O104	+
O105	RCL P
O106	+
O107	+/-
O108	STO A
O109	VIEW A
O110	RCL Y
O111	RCL W
O112	+
O113	RCL S
O114	+
O115	RCL T
O116	+
O117	RCL O

O118	+
O119	+/-
O120	STO B
O121	VIEW B
O122	RCL A
O123	RCL B
O124	O, r --> y, x
O125	STO C
O126	X < > Y
O127	180
O128	+
O129	STO D
O130	RCL C
O131	VIEW C
O132	RCL D
O133	VIEW D
O134	STOP
O135	GTO O
O136	RTN

HORIZONTAL CURVES

HORIZONTAL CURVES

SYMBOLS:

R - RADIUS
I - DELTA

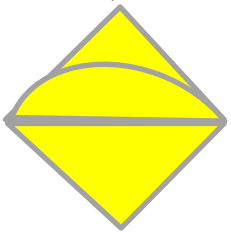
OPTIONAL:

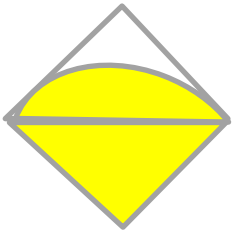
B - BEGINNING OF CURVE (BC)
P - POINT OF INTERSECTION (PI)

RESULTS:

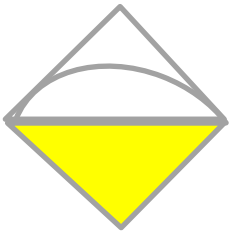
T - TANGENT
C - LONG CHORD
L - LENGTH OF CURVE
M - MIDDLE ORDINATE
E - EXTERNAL DISTANCE

Z - AREA SHADED (SQUARE FEET)

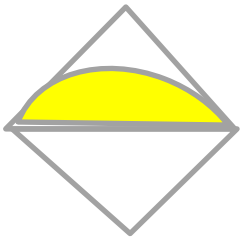




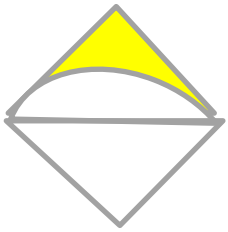
Y - AREA SHADED (SQUARE FEET)



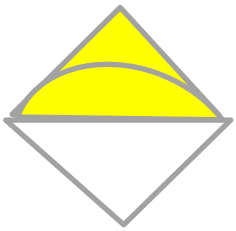
X - AREA SHADED (SQUARE FEET)



W - AREA SHADED (SQUARE FEET)



U - AREA SHADED (SQUARE FEET)



V - AREA SHADED (SQUARE FEET)

OPTIONAL:

IF B IS GIVEN

K - POINT OF INTERSECTION (PI)
G - END OF CURVE STATION

IF P IS GIVEN

F - BEGINNING OF CURVE STATION
N - END OF CURVE STATION

HP33s PROGRAM FOR HORIZONTAL CURVES

	XEQ Q
Q001	LBL Q
Q002	INPUT R
Q003	INPUT I
Q004	INPUT B
Q005	INPUT P
Q006	RCL R
Q007	RCL I
Q008	→HR
Q009	2
Q010	÷
Q011	TAN
Q012	x
Q013	STO T
Q014	VIEW T
Q015	RCL R
Q016	RCL I
Q017	→HR
Q018	2
Q019	÷
Q020	SIN
Q021	x
Q022	2
Q023	x
Q024	STO C
Q025	VIEW C
Q026	RCL R
Q027	RCL I
Q028	→HR
Q029	x
Q030	pi
Q031	x

Q032	180
Q033	÷
Q034	STO L
Q035	VIEW L
Q036	RCL R
Q037	RCL I
Q038	→HR
Q039	2
Q040	÷
Q041	COS
Q042	±
Q043	1
Q044	+
Q045	x
Q046	STO M
Q047	VIEW M
Q048	RCL I
Q049	→HR
Q050	2
Q051	÷
Q052	COS
Q053	1/x
Q054	1
Q055	-
Q056	RCL R
Q057	x
Q058	STO E
Q059	VIEW E
Q060	RCL P
Q061	RCL T
Q062	-
Q063	STO F
Q064	VIEW F
Q065	RCL F
Q066	RCL L
Q067	+
Q068	STO N
Q069	VIEW N
Q070	RCL B
Q071	RCL T
Q072	+
Q073	STO K
Q074	VIEW K
Q075	RCL B
Q076	RCL L
Q077	+
Q078	STO G
Q079	VIEW G
Q080	RCL T
Q081	RCL R
Q082	x
Q083	STO Z
Q084	VIEW Z
Q085	RCL R
Q086	RCL L

Q087	x
Q088	2
Q089	÷
Q090	STO Y
Q091	VIEW Y
Q092	RCL R
Q093	x2
Q094	RCL I
Q095	→HR
Q096	SIN
Q097	x
Q098	2
Q099	x
Q100	STO X
Q101	VTEW X
Q102	RCL Y
Q103	RCL X
Q104	-
Q105	STO W
Q106	VIEW W
Q107	RCL Z
Q108	RCL Y
Q109	-
Q110	STO U
Q111	VIEW U
Q112	RCL Z
Q113	RCL X
Q114	-
Q115	STO V
Q116	VIEW V
Q117	R/S (STOP)
Q118	GTO Q
Q119	RTN

VERTICAL CURVES

VERTICAL CURVES

1 **SYMBOLS:**

G = G1 IN %
H = G2 IN %
L = L, LENGTH OF VERTICAL CURVE

RESULTS:

R = RATE OF CHANGE
X = HIGH OR LOW POINT LOCATION FROM BVC
M = MIDDLE ORDINATE

2 **SYMBOLS:**

B = BVC STATION
C = BVC ELEVATION
D = DISTANCE FROM BVC

RESULTS:

Y = ELEVATION AT ANY POINT AT DIST. D
S = SLOPE AT ANY POINT AT DIST. D
O = OFFSET FROM GRADE LINE TO CURVE
Z = ELEVATION OF HIGH OR LOW POINT
I = STATION OF HIGH OR LOW POINT

3 **SYMBOLS:**

P = PVI STATION
Q = PVI ELEVATION

RESULTS:

B = BVC STATION
C = BVC ELEVATION
E = EVC STATION
K = EVC ELEVATION

4 **SYMBOLS:**

E = EVC STATION
K = EVC ELEVATION

RESULTS:

P = PVI STATION
Q = PVI ELEVATION
B = BVC STATION
C = BVC ELEVATION

NOTE:

LENGTH OF CURVE AND ALL STATIONS MUST BE IN DIVISIBLE BY 100 WHEN PLUGGING INTO HP33s.
EX.
STA. 45+12.36
PLUG-IN = 45.1236

XEQ V

```
V001    LBL V
V002    INPUT G
V003    INPUT H
V004    INPUT L
V005    EQN (G-H)÷L
V006    ABS
V007    STO R
V008    EQN (GxL)÷(G-H)
V009    STO X
V010    EQN ((G-H)XI)÷ABS(G-H)
V011    STO M
V012    VIEW R
V013    VIEW X
V014    VIEW M
V015    R/S
V016    INPUT B
V017    INPUT C
V018    INPUT D
V019    EQN C+(GxD)+(0.5xRxD^2)
V020    STO Y
V021    EQN C+(GxX)+(0.5xRxX^2)
V022    STO Z
V023    EQN ((GxL)-(Dx(G-H)))÷L
V024    STO S
V025    EQN (4xMxD^2)÷L^2
V026    STO O
V027    EQN B+X
V028    STO I
V029    VIEW Y
V030    VIEW S
V031    VIEW Z
V032    VIEW I
V033    VIEW O
V034    R/S
V035    INPUT P
V036    INPUT Q
V037    EQN P-(0.5xL)
V038    STO B
V039    EQN Q+(0.5xLxG)x(-1)
V040    STO C
V041    EQN P+(0.5xL)
V042    STO E
V043    EQN Q+(0.5xLxH)x(-1)
V044    STO K
V045    VIEW B
V046    VIEW C
V047    VIEW E
V048    VIEW K
V049    R/S
V050    INPUT E
V051    INPUT K
V052    EQN E-(0.5xL)
V053    STO P
V054    EQN K+(0.5xLxH)x(-1)
V055    STO Q
```

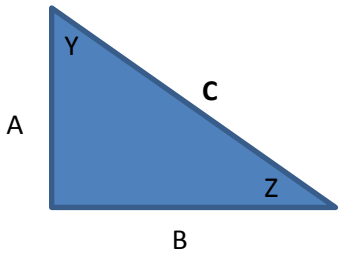
V056	EQN E-L
V057	STO B
V058	EQN Q+(0.5xLxG)x(-1)
V059	STO C
V060	VIEW P
V061	VIEW Q
V062	VIEW B
V063	VIEW C
V064	R/S
V065	GTO V
V066	RTN

RIGHT TRIANGLE

RIGHT TRIANGLE

FUNCTION:

SIN
COS
TAN



SYMBOLS:

A = SIDE
B = SIDE
C = SIDE
Z = ANGLE
Y = ANGLE
T = AREA

	XEQ P
P001	LBL P
P002	INPUT A
P003	INPUT Z
P004	RCL Z
P005	→HR
P006	STO L
P007	EQN A ÷ sin(L)
P008	STO C
P009	EQN A ÷ tan(L)
P010	STO B
P011	EQN 90 -L
P012	STO Y
P013	EQN 0.5 x B x A
P014	STO T
P015	VIEW B
P016	VIEW C
P017	VIEW Y
P018	VIEW T
P019	R/S
P020	INPUT B
P021	EQN B x tan(L)
P022	STO A
P023	EQN B ÷ cos(L)

P024	STO C
P025	VIEW A
P026	VIEW C
P027	VIEW Y
P028	R/S
P029	INPUT C
P030	EQN C x sin(L)
P031	STO A
P032	EQN C x cos(L)
P033	STO B
P034	VIEW A
P035	VIEW B
P036	VIEW Y
P037	R/S STOP
P038	GTOP
P039	RTN

AZIMUTH - BEARING

AZIMUTH - BEARING

SYMBOLS:

A = ANGLE
Y = AZIMUTH
W = AZIMUTH
U = AZIMUTH

	XEQ Y
Y001	LBL Y
Y002	INPUT A
Y003	→HR
Y004	INPUT A
Y005	→HR
Y006	+
Y007	STO Z
Y008	→HMS
Y009	STO Y
Y010	VIEW Y
Y011	INPUT A
Y012	→HR
Y013	RCL Z
Y014	+
Y015	STO X
Y016	→HMS
Y017	STO W
Y018	VIEW W
Y019	INPUT A
Y020	→HR
Y021	RCL X
Y022	+
Y023	STO V
Y024	→HMS
Y025	STO U
Y026	VIEW U
Y027	R/S
Y028	GTO Y
Y029	RTN

SAMPLE PROBLEMS FOR SURVEY PROGRAMS AND EQUATIONS

SAMPLE PROBLEMS FOR HP33s SURVEY PROGRAMS AND EQUATIONS

EXAMPLE 1

DETERMINE THE AREA IN SQ.FT. AND ACRE UNITS OF THE GIVEN COORDINATES OF THE POLYGON

	NORTHING	EASTING
A	0	0
B	100	200
C	500	800
D	400	600

SOLUTION:

USING THE PROGRAM OF AREA BY COORDINATES

PRESS	DISPLAY		KEY-IN
XEQ F			
R/S	N?		0
R/S	E?		0
R/S	N?		100
R/S	E?		200
R/S	N?		500
R/S	E?		800
R/S	N?		400
R/S	E?		600
R/S	N?		0
R/S	E?		0
	P=		
R/S	1889.434	FT.	
	F=		
R/S	20000	SQ.FT.	
	A=		
	0.459	ACRE	

EXAMPLE 2

IF THE COORDINATES OF POINT A IS N 1000 E 1000. DETERMINE THE NORTHING AND EASTING OF POINT C ON THE FOLLOWING GIVEN COURSES

COURSE	BEARING	DISTANCE
AB	N43°25'59"E	126.11 FT.
BC	S61°54'59"E	159.10 FT.
CD	S69°12'16"W	159.10 FT.

SOLUTION

CONVERT ALL BEARINGS INTO AZIMUTH

COURSE	BEARING	**AZIMUTH**	DISTANCE
AB	N43°25'59"E	43.2559	126.11 FT.
BC	S61°54'59"E	118.0501	159.10 FT.
CD	S69°12'16"W		159.10 FT.

USING THE PROGRAM OF TRAVERSE

PRESS	**DISPLAY**		**KEY-IN**
XEQ T			
	N?		1000
R/S	E?		1000
R/S	A?		43.2559
R/S	D?		126.11
R/S			
	N?		
R/S	1091.578		
	E?		
R/S	1086.702		
R/S	A?		118.0501
R/S	D?		159.1
R/S			
	N?		
R/S	1016.681		
	E?		
	1227.069		

POINT C (N 1016.681 E 1227.069)

EXAMPLE 3.

FROM THE GIVEN DATA OF A CLOSED TRAVERSE.
COMPUTE THE AREA BY DMD METHOD

LINES	BEARING	DISTANCES
AB	S 32°17' W	22.04
BC	N 36°25' W	10
CD	N 15°47' W	5
DA	N 73°07' E	19.95

SOLUTION
CONVERT ALL BEARINGS INTO AZIMUTH

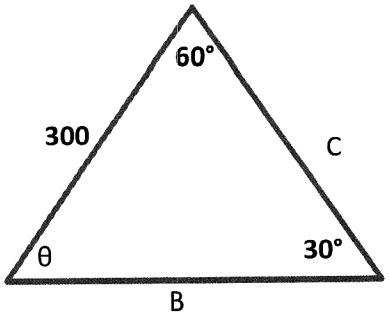
LINES	BEARING	**AZIMUTH**	DISTANCES
AB	S 32°17' W	212.17	22.04
BC	N 36°25' W	323.35	10
CD	N 15°47' W	344.13	5
DA	N 73°07' E	73.07	19.95

USING PROGRAM DMD METHOD

PRESS	**DISPLAY**		**KEY-IN**
XEQ O			
	A?		212.17
R/S	B?		22.04
R/S	C?		323.35
R/S	D?		10
R/S	E?		344.13
R/S	F?		5
R/S	G?		73.07
R/S	H?		19.95
R/S	I?		0
R/S	J?		0
	Z=		
	152.962	SF	

EXAMPLE 3.

FIND THE MISSING SIDES AND INCLUDED ANGLE OF THE TRIANGLE SHOWN BELOW. DETERMINE THE AREA IN SQUARE FEET.



SOLUTION

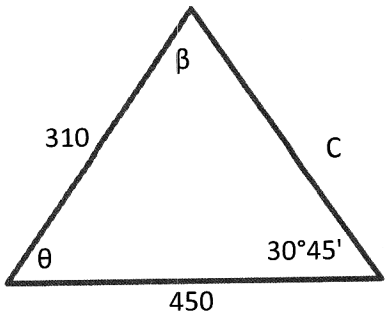
USING **AAS** PROGRAM FROM HP33

PRESS	DISPLAY		KEY-IN
XEQ C			
	D?		30
R/S	E?		60
R/S	A?		100
R/S	B=		
	519.615	FT	
R/S	C=		
	600	FT	
R/S	F=	θ	
	90	ANGLE	
R/S	G=		
	77942	SF	
R/S	H=		
	1.789	AC.	

NOTE:
AS PER HP33s PROGRAM FOR THE TRIANGLES ALWAYS REMEMBER THAT THE DESIGNATED VARIABLE LETTER FOR THE ANGLES ARE D, E. F, AND FOR THE SIDES ARE A,B, AND C ALSO G IS FOR AREA IN SF. PLUGGING VALUES IN HP33s IS ALWAYS STARTS AT COUNTER CLOCKWISE.

EXAMPLE 4.

FIND THE MISSING SIDES AND INCLUDED ANGLE OF THE TRIANGLE SHOWN BELOW. DETERMINE THE AREA IN SQUARE FEET.



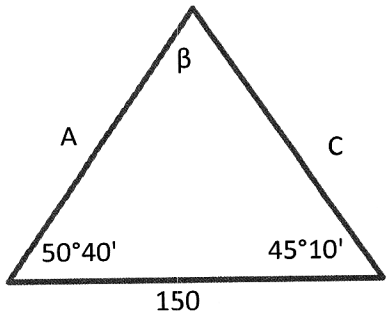
SOLUTION

USING **SSA** PROGRAM FROM HP33

PRESS	DISPLAY		KEY-IN
XEQ C			
	A?		310
R/S	B?		450
R/S	D?		30.45
R/S	C=		
	594.488	**FT**	
R/S	**E=**	**β**	
	47°55'09"	**ANGLE**	
R/S	**F=**	**θ**	
	19°19'51"	**ANGLE**	
R/S	**G=**		
	68390.499	**SF**	
R/S	**H=**		
	1.57	**AC.**	

EXAMPLE 6.

FIND THE MISSING SIDES AND INCLUDED ANGLE OF THE TRIANGLE SHOWN BELOW. DETERMINE THE AREA IN SQUARE FEET.

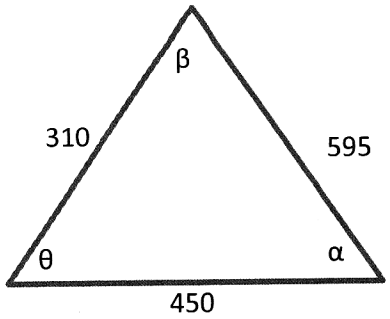


SOLUTION

USING **ASA** PROGRAM FROM HP33

PRESS	DISPLAY		KEY-IN
XEQ D			
	F?		50.4000
R/S	B?		150.00
R/S	D?		45.1000
R/S	A=		
	106.927	**SIDE, FT**	
R/S	**C=**	**C**	
	600	**SIDE, FT**	
R/S	**E=**	**θ**	
	84°10'	**ANGLE**	
R/S	**G=**		
	6202.92	**SF**	
R/S	**H=**		
	0.1424	**AC.**	

FIND THE MISSING SIDES AND INCLUDED ANGLE OF THE TRIANGLE SHOWN BELOW. DETERMINE THE AREA IN SQUARE FEET.



SOLUTION

USING **SSS** PROGRAM FROM HP33

PRESS	DISPLAY		KEY-IN
XEQ C			
	A?		310
R/S	B?		450
R/S	C?		30.45
R/S	**D=**		
	30.422	**ANGLE**	
R/S	**E=**	**β**	
	47°50'10"	**ANGLE**	
R/S	**F=**	**θ**	
	101°27'30"	**ANGLE**	
R/S	**G=**		
	68359.833	**SF**	
R/S	**H=**		
	1.569	**AC.**	

EXAMPLE 8.

THE BEGINNING OF CURVE STATION OF A ROAD IS 10+00 AND ITS END CURVE STATION IS 18+00. THE CURVE HAS A RADIUS OF1200 AND A CENTRAL ANGLE OF 39°12'. FIND THE FOLLOWING:

A. TANGENT

B. LONG CHORD

C. LENGTH OF CURVE
D. MIDDLE ORDINATE
E. EXTERNAL DISTANCE

SOLUTION:

PLUG THE GIVEN VALUE
USING HORIZONTAL CURVES PROGRAM IN HP33s

PRESS	DISPLAY		KEY-IN
XEQ Q			
	R?		1200
R/S	I?		39.12
R/S	**T=**		
	427.3		
R/S	**C=**		
	805.08		
R/S	**L=**		
	821		
R/S	**M=**		
	69.53		
R/S	**E=**		
	73.81		

EXAMPLE 9.

FIND THE BEARING AND DISTANCE OF A LINE WITH N 4321.123 E 6784.879 AND N 2657.098 E 5362.253 RESPECTIVELY.

SOLUTION:

THIS IS AN INVERSE PROBLEM

USING THE INVERSE PROGRAM OF HP33s

PRESS	DISPLAY		KEY-IN
XEQ I			
	N?		4321.123

R/S	E?		6784.879
R/S	Y?		2657.098
R/S	X?		5362.253
R/S	**D=**		
	2189.256		
R/S	**A=**		
	3.083		

BEARING	**N 03°08'30" E**
DISTANCE	**2189.256**

EXAMPLE 10.

A PARABOLIC CURVE IS FOUND IN A PROFILE WITH G1 OF 2.5% AND G2 OF -3.2%. THE LENGTH OF CURVE IS 800 FEET WITH PVI STATION 50+00 AND PVI ELEVATION 950 FEET. FIND THE FOLLOWING:

A. RATE OF CHANGE
B. HIGH OR LOW POINT LOCATION
C. MIDDLE ORDINATE
D. AT 350 FT. FROM BVC SOLVE FOR THE ELEV.
E. SOLVE FOR THE SLOPE OF QUESTION D.
F.BVC STATION
G. BVC ELEVATION
H. EVC STATION
I. EVC ELEVATION

SOLUTION:

USING VERTICAL CURVES PROGRAM

NOTE: DISTANCES AND STATIONS MUST BE IN NUMBER OF HUNDREDS

PRESS	DISPLAY		KEY-IN
XEQ V			

	G?		2.5
R/S	H?		-3.2
R/S	L?		8
R/S	**R=**		
	0.7125	**A**	
R/S	**X=**		
	3.5088	**B**	
R/S	**M=**		
	8	**C**	
R/S	3.5088		
	8		
R/S	D?		3.5
R/S	C?		940
R/S	B?		46
R/S	**Y=**		
	953.114	**D**	
R/S	**S=**		
	0.0063	**E**	
R/S	**O=**		
	6.125		
R/S	**I=**		
	49.5088		
R/S	**Z=**		
	953.158		
R/S	49.5088		
	953.1579		
R/S	P?		50
R/S	Q?		950
R/S	**B=**		
	46	**F**	
	C=		
	940	**G**	
	E=		
	54	**H**	
	K=		
	962.8	**I**	