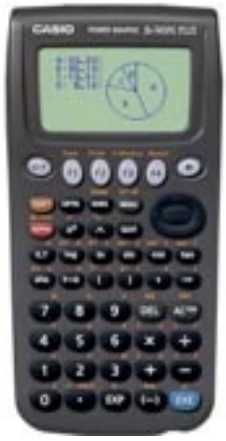
CASIO *fx-7400G PLUS* **POWER GRAPHIC**

Engineering Surveyor Programs

Reference Manual

Revision 3.0: November 2009



ENGINEERING SURVEYOR

www.engineeringsurveyor.com

CONTENTS

INTRODUCTION

Instructions

The following pages illustrate the programs contained within the file "my_progs.fxi".

This file can only be opened using the "Casio Interface" software that is supplied with the "PC-Casio" interface cable.

Each program may be uploaded to the Casio individually.

The programs have been tested thoroughly, but any results should be confirmed by other means where possible. These programs are provided free of charge "as-is". The author does not take any responsibility for any data loss through the use of these programs.

Manual Programming

Using the program listings, each file may be manually typed into the Casio calculator. However, care should be taken to avoid typographical mistakes, such as distinguishing between 1 & i and 0 (zero) & o.

Casio Key Sequences

The following shortcuts are quick ways to find various program commands when programming the Casio fx7400g+.

Pol(	OPTN ▶F2 ▶▶F1
If	SHIFT VARS F1 F1
Then	SHIFT VARS F1 F2
Else	SHIFT VARS F1 F3
IfEnd	SHIFT VARS F1 F4
Lbl	SHIFT VARS F3 F1
Goto	SHIFT VARS F3 F2
Fix	SHIFT MENU ▶▶F1

Degrees Minutes and Seconds

Entering Angles

To enter angles in degrees, minutes and seconds into the Casio fx7400g+, the following key presses are required…

eg 123° 45’ 56”

INPUT	DISPLAY
123	123
[OPTN]	
[►]	
[F2] (ANGL)	
[►]	
[F1] (°’”)	123°
45	123° 45
[F1] (°’”)	123° 45°
56	123° 45° 56
[F1] (°’”)	123° 45° 56°
[EXE]	

Converting Decimal Degrees to D/M/S

The following example converts a decimal degree value into displaying Degrees, Minutes and Seconds.

eg. 246.8083246°

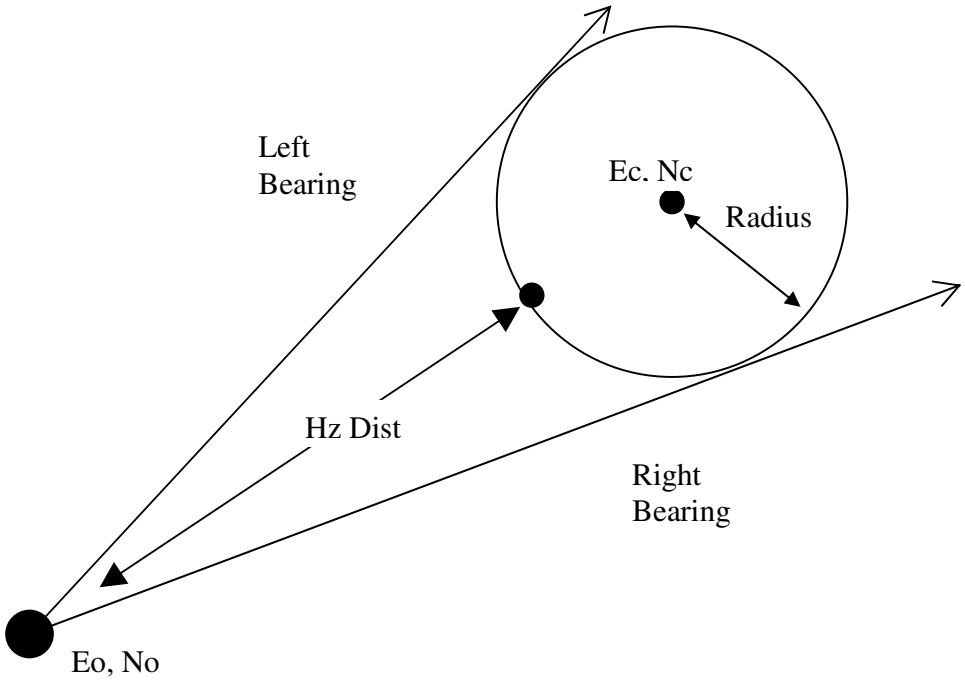
[OPTN]	246.8083246
[►]	246.8083246
[F2] (ANGL)	246.8083246
[►]	246.8083246
[F2] ($\overline{°’”}$)	123° 48’ 29”

1PT~CFIX

Introduction

Calculates the centre of a circle using observed whole circle bearings to both edges and a measured distance to the nearest point in a line through the centre..

Diagram



Input

Station Co-ordinates:	(Eo, No)
Hz Angle to Left Side:	Left Bearing
Hz Angle to Right Side:	Right Bearing
Hz Dist to Centre:	Hz Dist

Output

Centre Co-ordinates:	(Ec, Nc)
Radius:	R
Diameter:	D

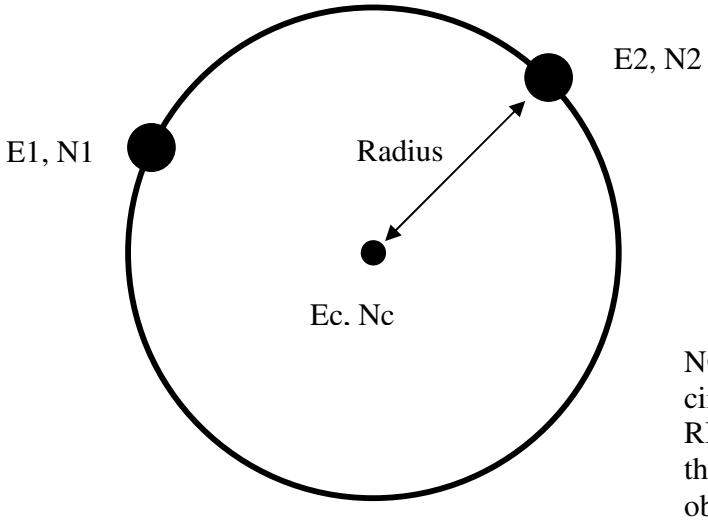
2PT~CFIX

Introduction

Calculates the centre of a circle given the co-ordinates of 2 points on its perimeter.

NOTE: 2 solutions are possible.

Diagram



NOTE: In this case the circle centre is to the RIGHT of the points in the order they were observed.

Input

Co-ordinates of 2 known points:	(E1, N1) (E2, N2)
Direction of Centre from points:	Left or Right
Radius:	R

Output

Centre Co-ordinates:	(Ec, Nc)

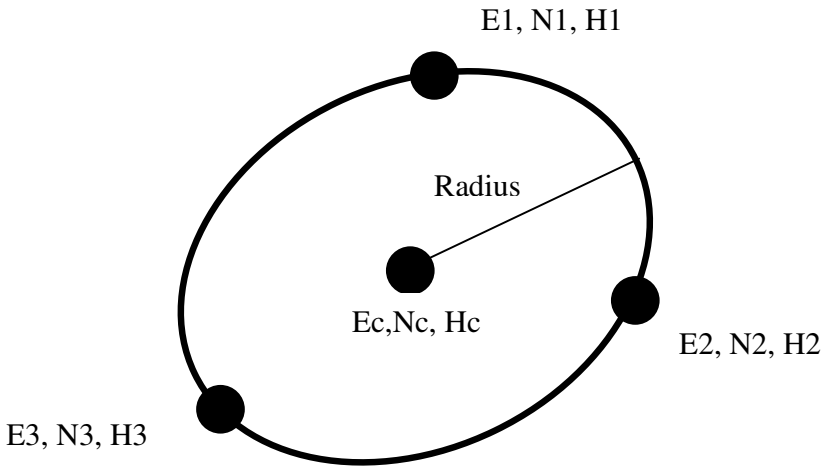
3D~CFIX

Introduction

Calculates the centre of a circle given the co-ordinates of 3 (x,y,z) points on its perimeter. The circle may be at any angle from any axis.

The points may be input in any order.

Diagram



Input

3D co-ordinates of 3 known points:	(E1, N1, H1) (E2, N2, H2) (E3, N3, H3)

Output

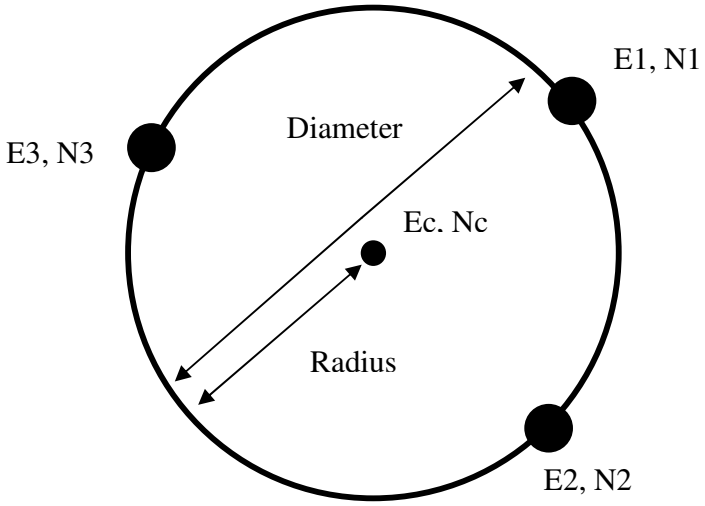
Centre Co-ordinates:	(Ec, Nc, Hc)
Radius:	R

3PT~CFIX

Introduction

Calculates the centre of a circle given the co-ordinates of 3 points on its perimeter.

Diagram



Input

Co-ordinates of 3 known points:	(E1, N1) (E2, N2) (E3, N3)

Output

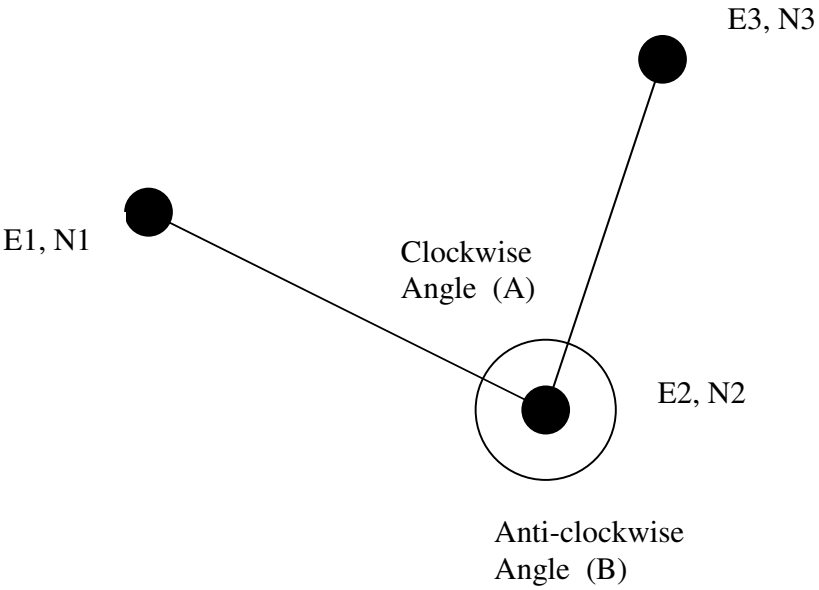
Centre Co-ordinates:	(Ec, Nc)
Radius:	R
Diameter:	D

ANGLE

Introduction

Calculates the clockwise and anti-clockwise angles between 3 known points.

Diagram



Input

Co-ordinates of 3 nodes: (E1, N1) (E2, N2) (E3, N3)

Output

Clockwise angle: A
Anti-clockwise angle: B

Note:

The output results are clockwise and anti-clockwise angles, NOT necessarily internal or external angles.

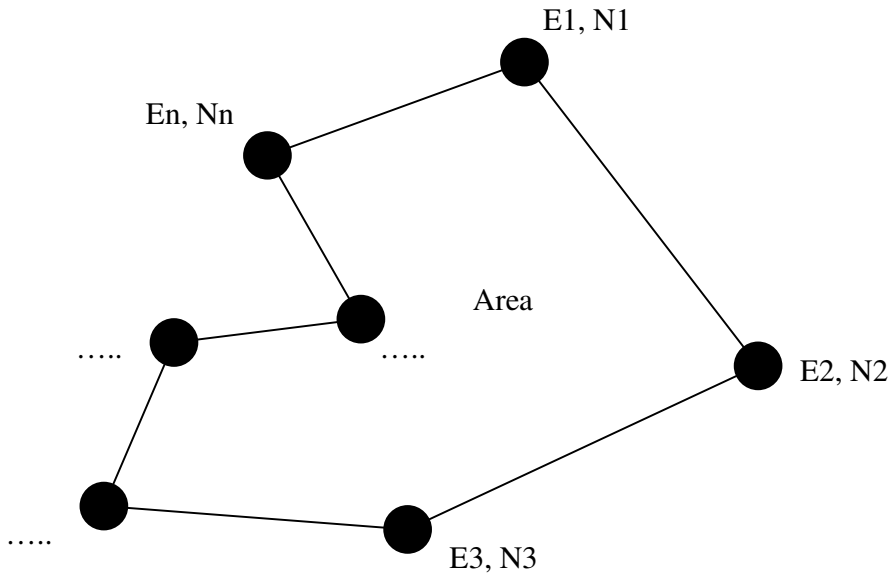
AREA

Introduction

Calculates the area of an enclosed polygon given the co-ordinates of any number of nodes.

Note: The polygon is closed by re-entering the first co-ordinate at the end of the loop.

Diagram



Input

Co-ordinates of nodes: (E1, N1) (E2, N2) (E3, N3) ……. (En, Nn) (E1 N1)

Output

No of Nodes: n
Total enclosed area: Area

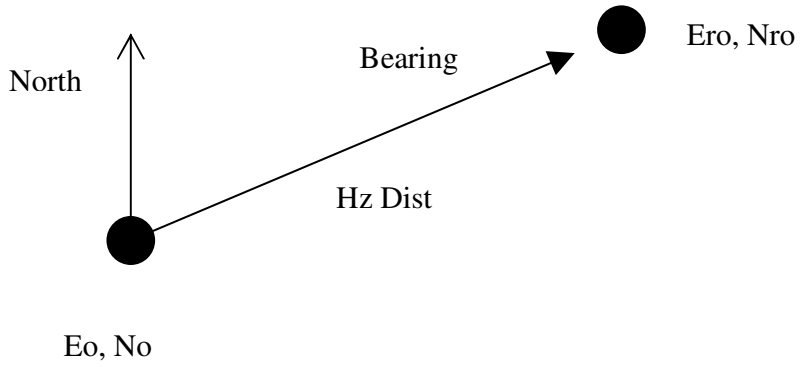
BRG~DIST

Introduction

Calculates the whole circle azimuth and distance between two known points.

Co-ordinates are entered from Station to RO.

Diagram



Input

Station Co-ordinates:	(Eo, No)
Reference Object Co-ordinates:	(Ero, Nro)

Output

Bearing:	Bearing
Hz Distance:	Hz Dist

CIRCLE

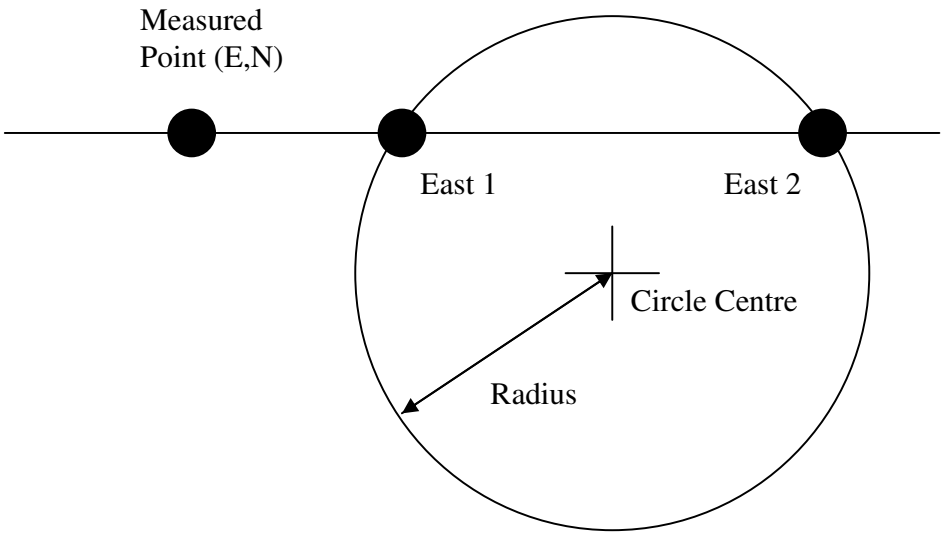
Introduction

This program calculates two ordinate values of a circle, given another ordinate. ie: Given a Northing which passes through any given circle, the program will calculate two Easting values that the circle crosses.

This program has been used for setting-out curved edge-trim where the centre of radius is outside of the building.

If the given ordinate does not pass through the circle; a message is displayed.

Diagram



Input

Circle Centre:	(E, N)
Circle Radius:	R
Ordinate:	E or N

Output

Circle crossing ordinates: N or E

COLUMN

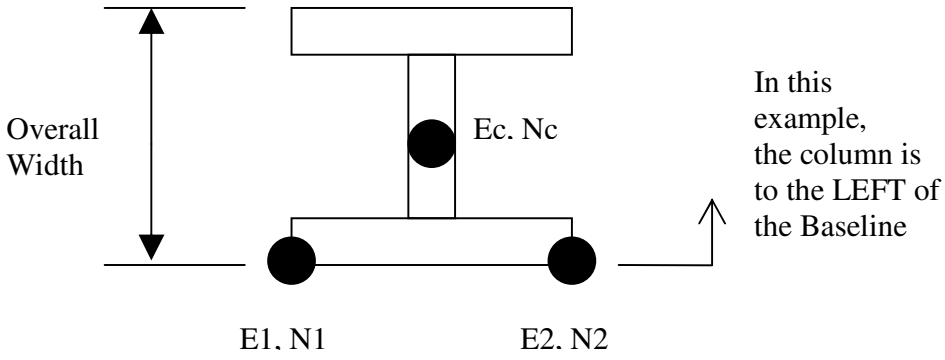
Introduction

Determines the centre of a column given the co-ordinates of two adjacent corners and the overall width of the column section.

The column direction from the baseline must be given as “to the left” or “to the right”.

A check is also made to determine the squareness of the observations/column.

Diagram



Input

Two corner co-ordinates:	(E1, N1) (E2, N2)
Overall Column Width:	Width

Output

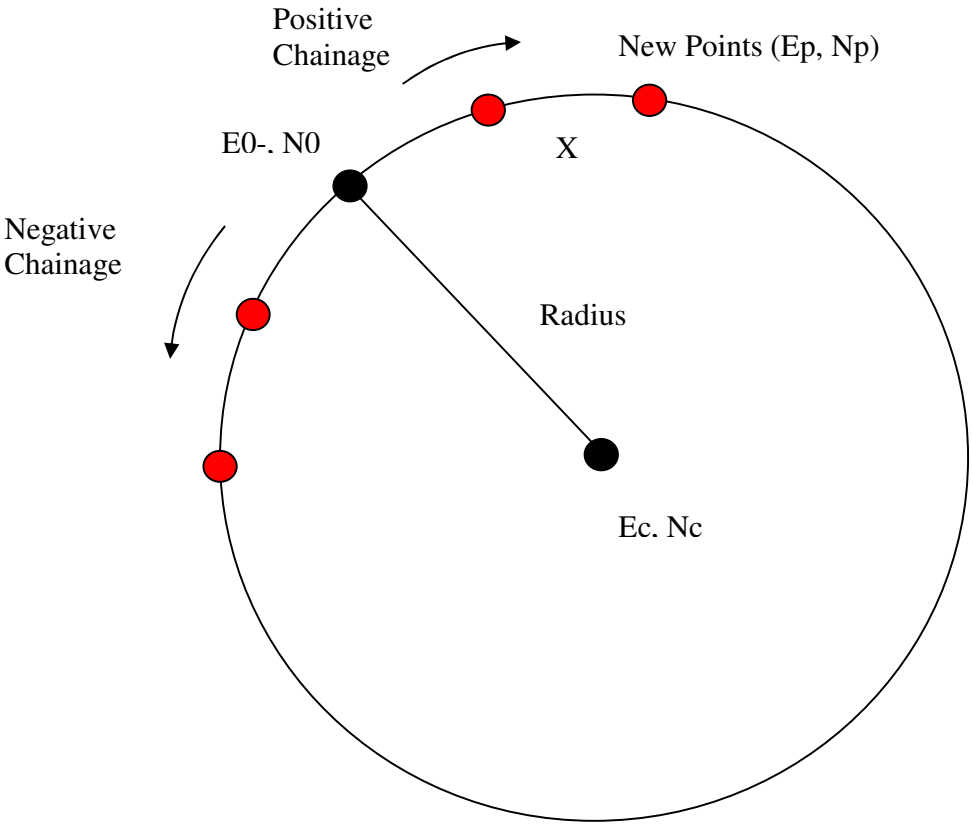
Squareness:	S
Column Centre Co-ordinates:	(Ec, Nc)

CURVE

Introduction

Determines the setting-out co-ordinates of points on a curve.

Diagram



Input

Circle Centre:	(Ec, Np)
Starting Point:	(E0, N0)
+'ve or –'ve Chainage:	X

Output

Radius:	R
Curve Points:	(Ep, Np)

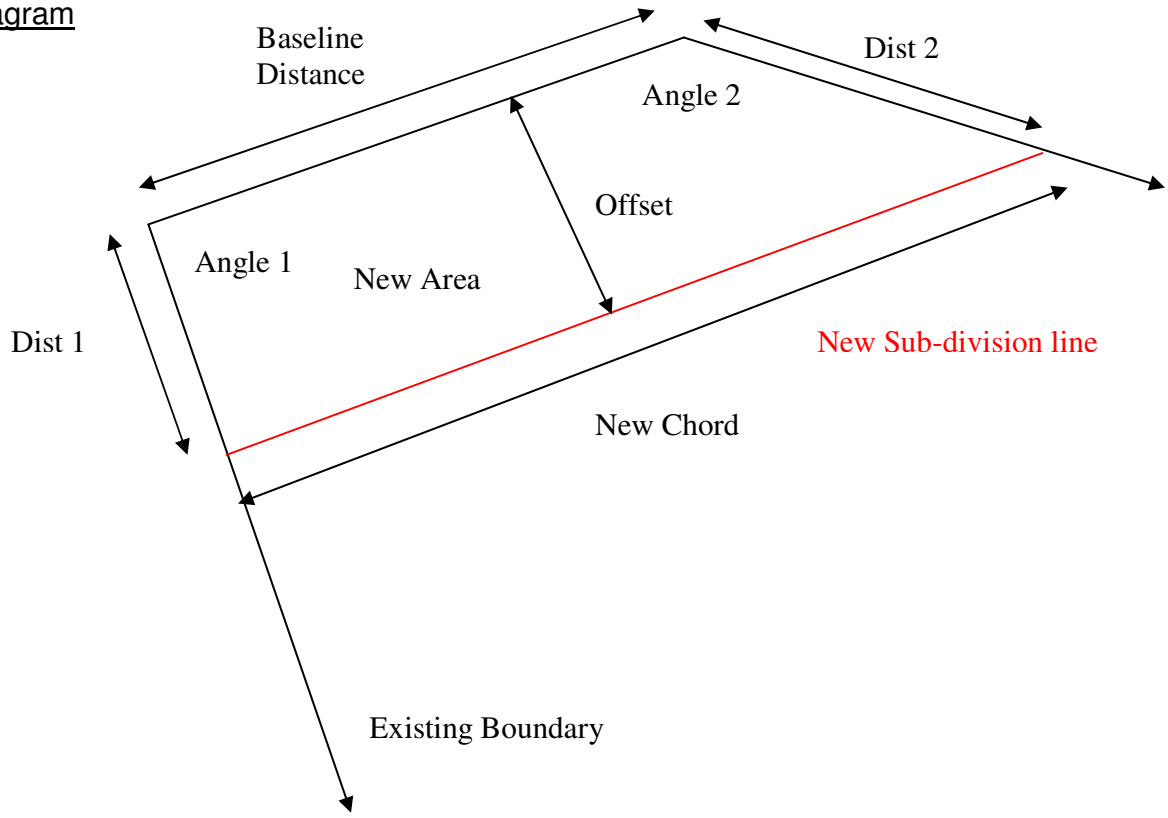
CUT~AREA

Introduction

Determines the location of a cut-line for the sub-division of a Plot into a known area. New sub-division line is parallel to existing boundary.

Note: Angles may be internal or external and in any order. Example shown only.

Diagram



Input

Baseline Distance:	Distance
Required Area (m²):	New Area
Angles 1 & 2:	θ1 & θ2

Output

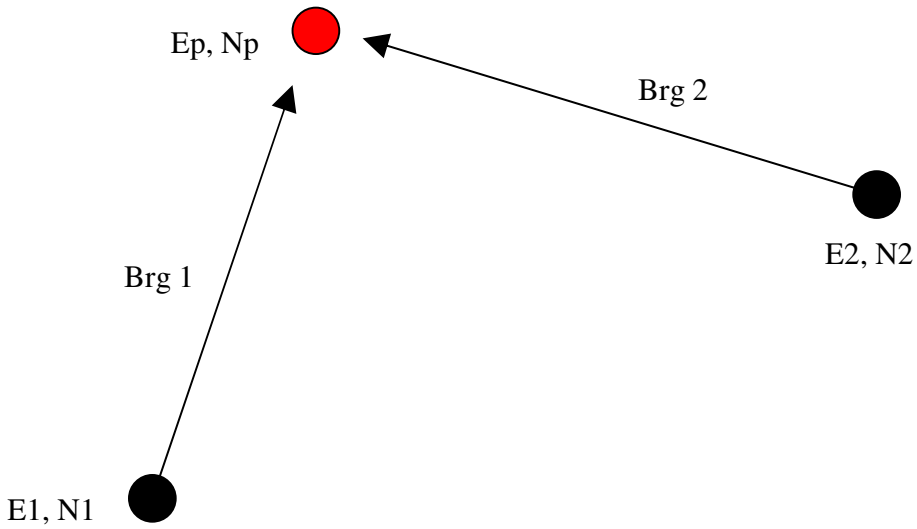
Distance along adjacent legs:	D1 & D2 (in same order as angles were input)
Offset distance:	Offset
Cross plot “Chord” distance:	Chord Distance

INT~SECT

Introduction

This programs calculates the 2-D co-ordinates of an unknown point given the co-ordinates of two known points and two intersecting bearings from them.

Diagram



Input

Known Stations:	(E1, N1) (E2, N2)
Bearings:	Bearing 1 & Bearing 2

Output

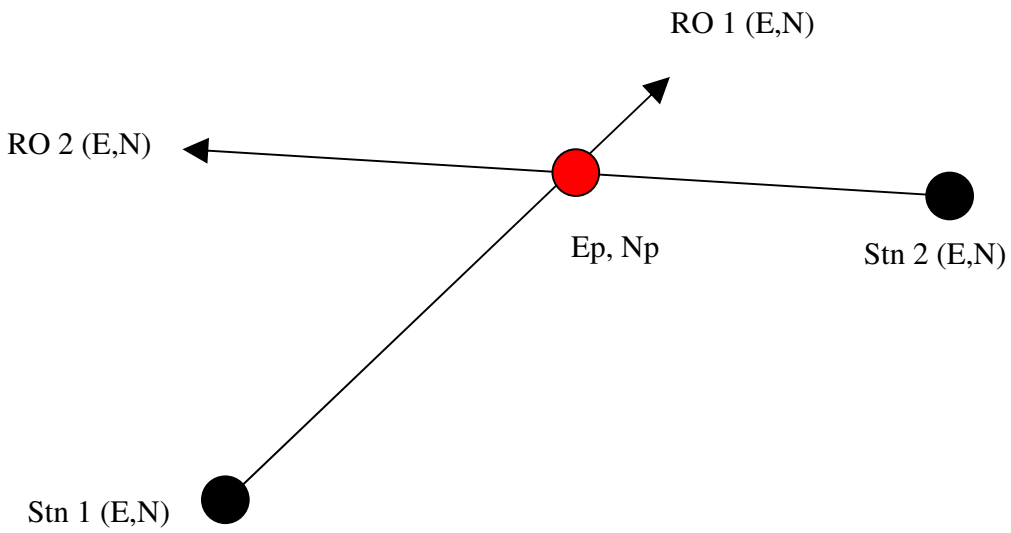
Intersection co-ordinates:	(Ep, Np)

INT~SECT2

Introduction

This programs calculates the 2-D co-ordinates of an unknown point from the intersecting lines between two sets of 2 points..

Diagram



Input

Known Stations:	Stn1 & Stn 2 (E, N)
Known Reference Points:	RO1 & RO2 (E, N)

Output

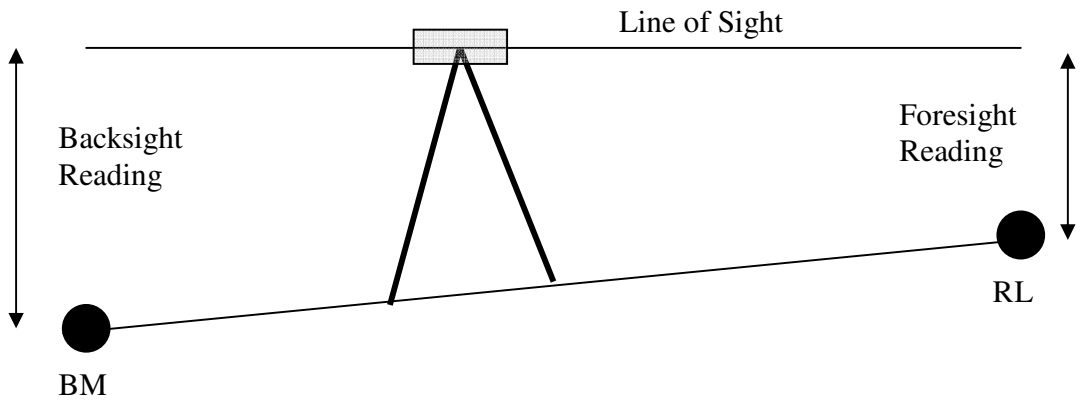
Intersection co-ordinates:	(Ep, Np)

LEVELS

Introduction

Computes the reduced level of any number of points using ordinary levelling techniques. Single set-up only.

Diagram



Input

Benchmark Value:	BM
Backsight Reading:	BS
Foresight Readings:	FS1, FS2, FS3…

Output

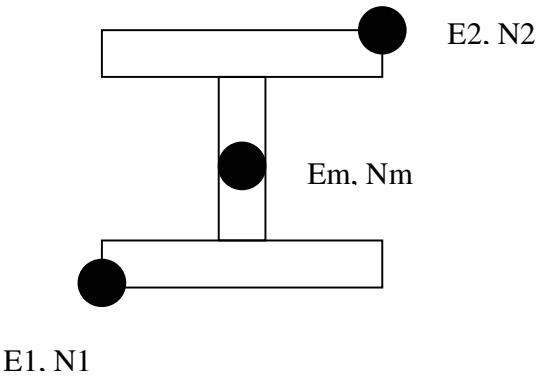
Reduced Levels:	RL1, RL2, RL3…

MEAN~XY

Introduction

Calculates the mean of two co-ordinates. eg. Two diagonal column corners.

Diagram



Input

Two co-ordinates: (E1, N1) (E2, N2)

Output

Mean co-ordinate: (Em, Nm)

NOTEBOOK

Introduction

Stores up to 9 numeric values when a pen and paper aren't available.

Input

Numeric values: N1, N2, N3…..N9

Output

Numeric values: N1, N2, N3…..N9

Note: The values may be overwritten/changed when another program is used. This program should only be used for temporary storage only.

OFFSET

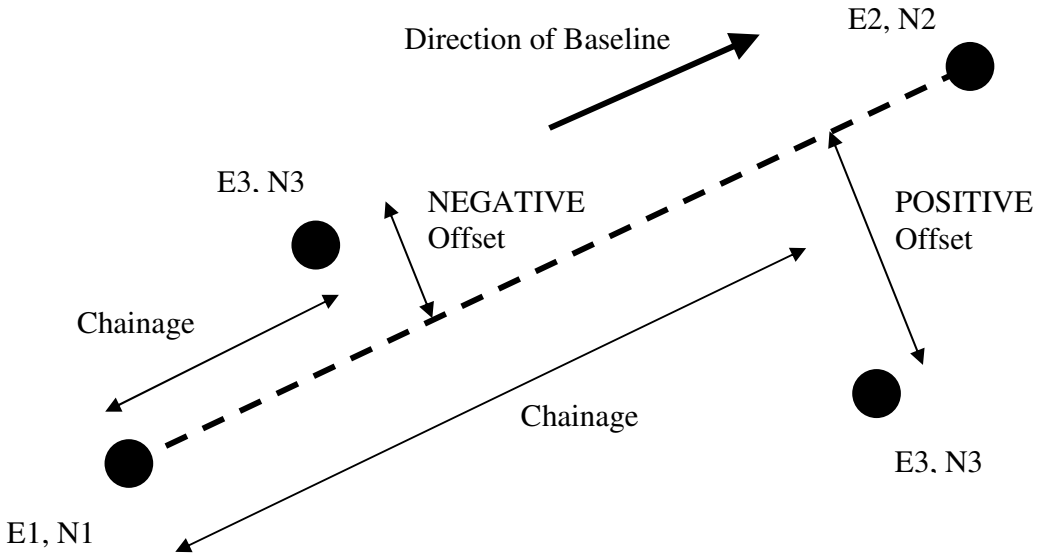
Introduction

This program calculates the perpendicular distance (offset) of a point from a given baseline, as well as the distance along the baseline to that perpendicular intersection (chainage).

Positive offsets are to the RIGHT of the line and negative offsets are to the LEFT of the line.

Note: Chainages can also be negative.

Diagram



Input

Baseline co-ordinates:	(E1, N1) (E2, N2)
Other points:	(E3, N3)

Output

Offset:	+/- Offset
Chainage:	Chainage

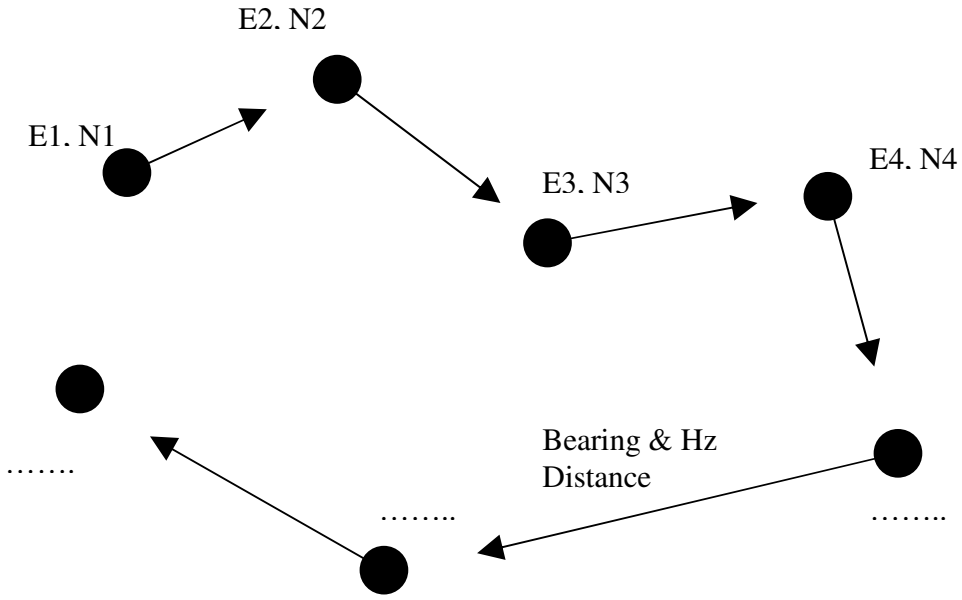
POLYGON

Introduction

Computes the “Bearing and Distances” between points in a series. eg Traverse.

The input of the data is quicker as each co-ordinate is entered only once.

Diagram



Input

Co-ordinates: (E1, N1) (E2, N2) (E3, N3) …….. (En, Nn)

Output

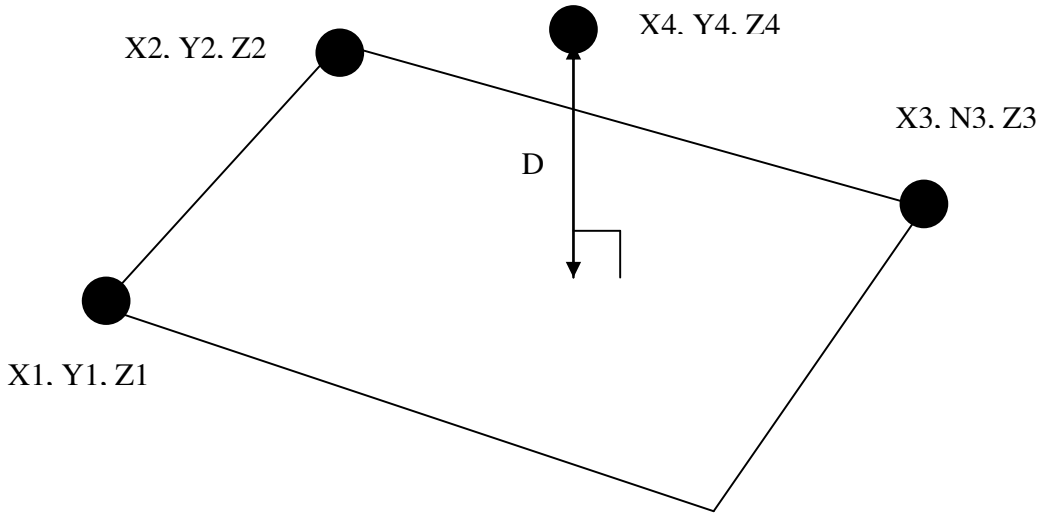
Bearing & Distances: (E1, N1) to (E2, N2)
(E2, N2) to (E3, N3)
(E3, N3) to …….

PT2PLANE

Introduction

This program calculates the perpendicular distance from a surveyed point to a known inclined plane (defined by 3 points). May be used to calculate non-flatness of a surface by defining 3 corners.

Diagram



Input

Plane co-ordinates: (X1, Y1, Z1) (X2, Y2, Z2) (X3, Y3, Z3)
Other points: (X4, Y4, Z4)

Output

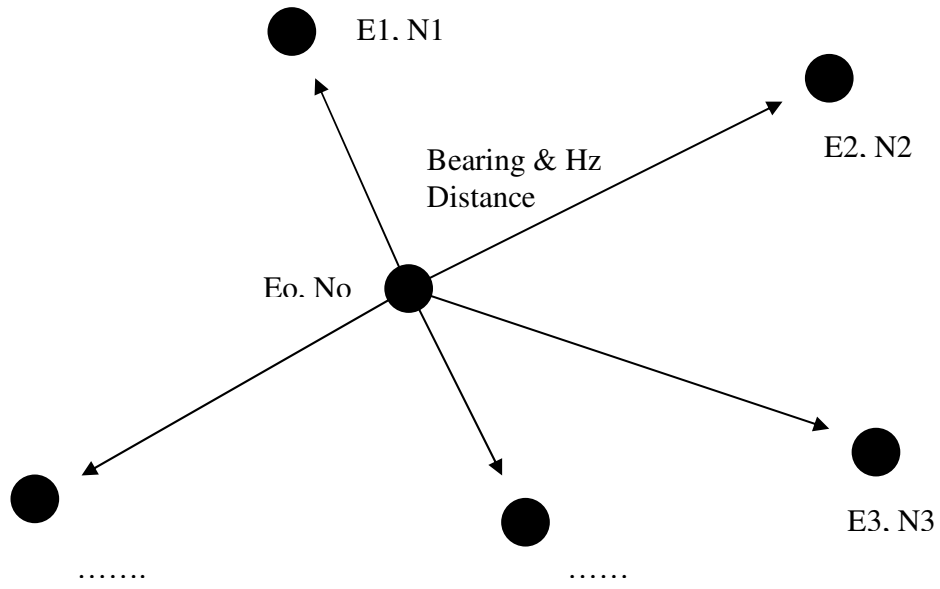
Perpendicular distance: D

RADIAL

Introduction

Computes the "Bearing & Distances" from a central point to any number of other points. This program removes the need to keep re-entering the first set of co-ordinates.

Diagram



Input

"From" co-ordinates:	(Eo, No)
"To" co-ordinates:	(E1, N1) (E2, N2) (E3, N3) …….

Output

Bearing & Distances:	(Eo, No) to (E1, N1)
	(Eo, No) to (E2, N2)
	(Eo, No) to (E3, N3) ……

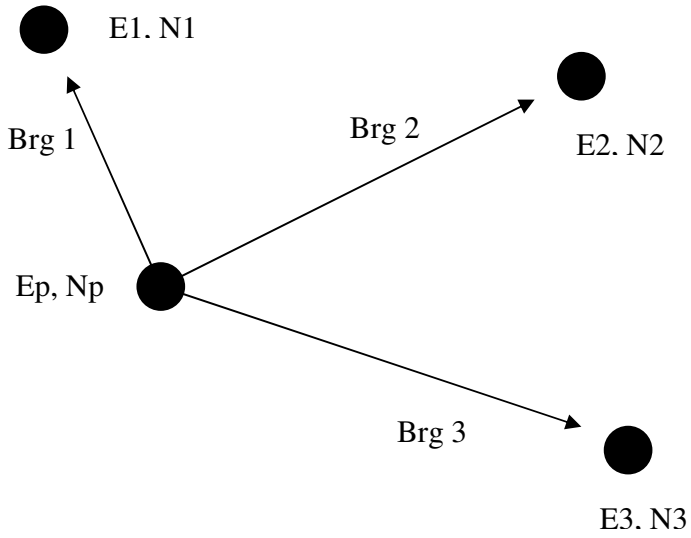
RESECT

Introduction

Computes the co-ordinates of an Instrument Station by observing three arbitrary bearings to three known points.

NOTE: The co-ordinates of the known stations must be entered and observed in a CLOCKWISE order.

Diagram



Input

Known co-ordinates: (E1, N1) (E2, N2) (E3, N3)
Arbitrary Bearings: Brg1 Brg 2 Brg 3

Output

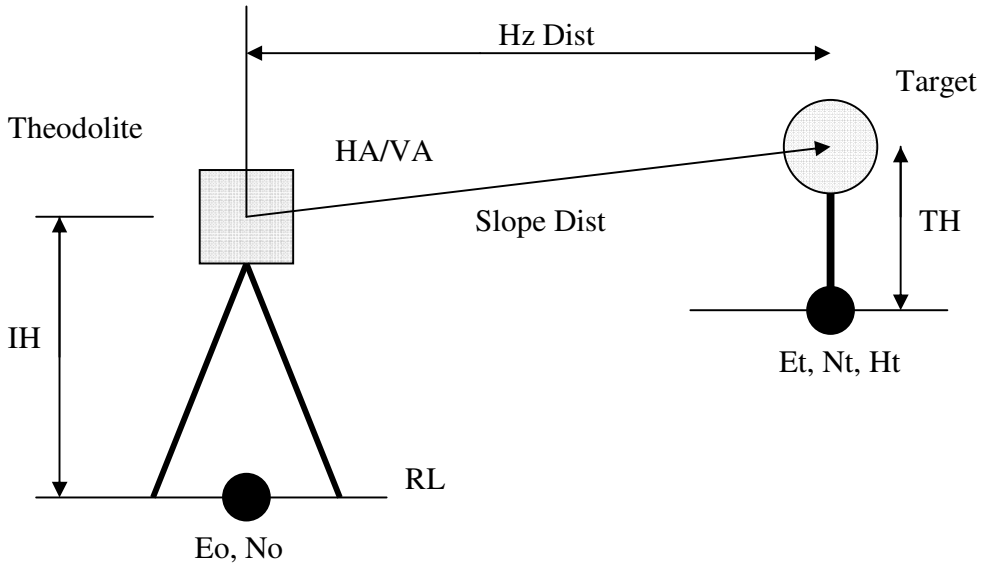
Resected co-ordinates: (Ep, Np)

SURVEY

Introduction

Reduces measured angles and distances to a target into X, Y, Z co-ordinates

Diagram



Input

Station Co-ordinates:	(Eo, No)
Station Reduced Level:	RL
Instrument Height:	IH
Known Bearing or RO Coords:	Bearing or (Ero, Nro)
Horizontal Angle:	Hz Ang
Vertical Angle:	VA
Slope or Hz Distance:	Slope or Hz Dist
Target Height:	TH

Output

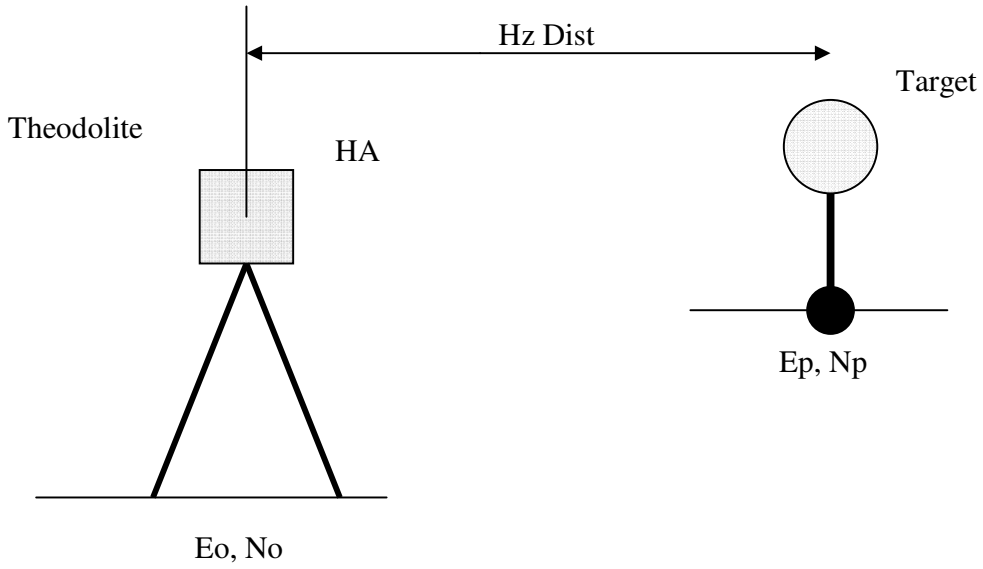
Target Co-ordinates:	(Et, Nt, Ht)
Hz Dist:	Hz Dist

SURVEY2D

Introduction

Simplified survey reduction program. Reduces 2D measured angles and distances to a target into X & Y co-ordinates.

Diagram



Input

Station Co-ordinates:	(Eo, No)
Known Bearing or RO Coords:	Bearing or (Ero, Nro)
Horizontal Angle:	Hz Ang
Hz Distance:	Hz Dist

Output

Target Co-ordinates:	(Ep, Np)

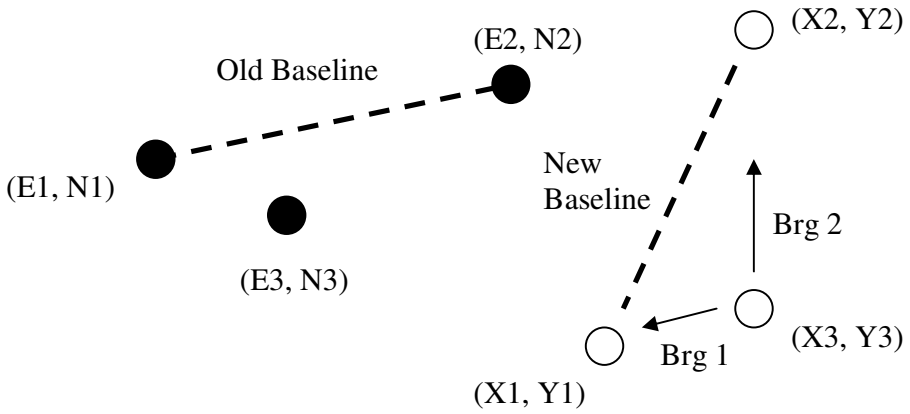
TRANSFRM

Introduction

This program uses two known points to transform any other points between two different co-ordinate systems. A baseline is used to calculate the Scale, Rotation and Translation parameters between the systems.

Calculates the new bearings to the new baseline in case this point is required as an instrument set-up.

Diagram



Input

Original co-ordinates:	(E1, N1) (E2, N2)
New co-ordinates:	(X1, Y1) (X2, Y2)
Other points:	(E3, N3) (E4, N4) (E5, N5) ….

Output

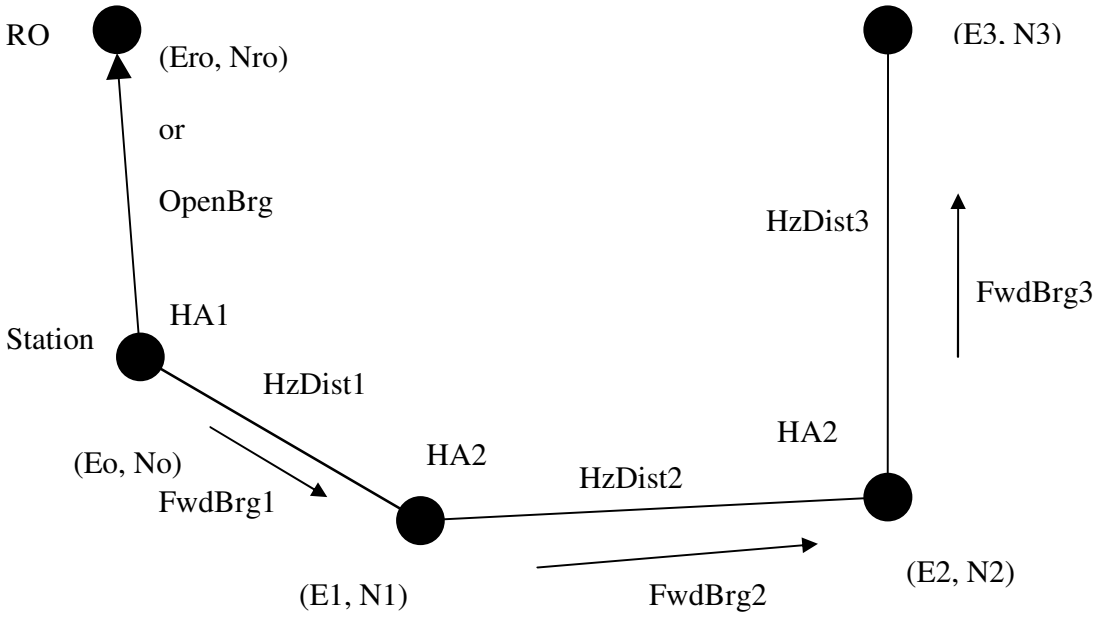
Original Baseline Distance:	Old Baseline
New Baseline Distance:	New Baseline
Scale Factor:	SF
Scale Error per Km:	Error/Km
Transformed Points:	(X3, Y3) (X4, Y4) (X5, Y5) …..
Bearings to Basepoints:	Brg 1, Brg 2

TRAVERSE

Introduction

Computes station co-ordinates of a traverse given a starting baseline and a series of measured horizontal angles and forward distances. The traverse may be left open or closed.

Diagram



Input

Station co-ordinates:	(Eo, No)
RO co-ords or Opening Bearing:	(Ero, Nro) or OpenBrg
Measured Angles:	HA1, HA2, HA3……
Measured Horz Distances:	HzDist1, HzDist2, HzDist3…….

Output

Forward Bearings:	FwdBrg1, FwdBrg2, FwdBrg3…..
Intermediate co-ordinates:	(E1, N1), (E2, N2), (E3, N3)….

UNI~COLS

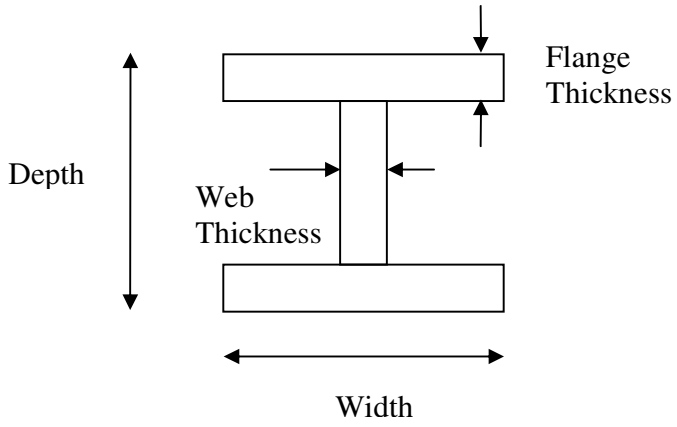
Introduction

Gives the Width/Depth and Flange/Web thicknesses of 31 no. Standard Universal Columns.

Designation must be 3 numbers separated by x (multiplyer) symbol.

Also allows you to view the Designations of all 31 no. columns.

Diagram



Input

UC Designation: AAAxBBBxCCC

Output

Column Dimensions: Depth, Width, Flange, Web

VECTORS

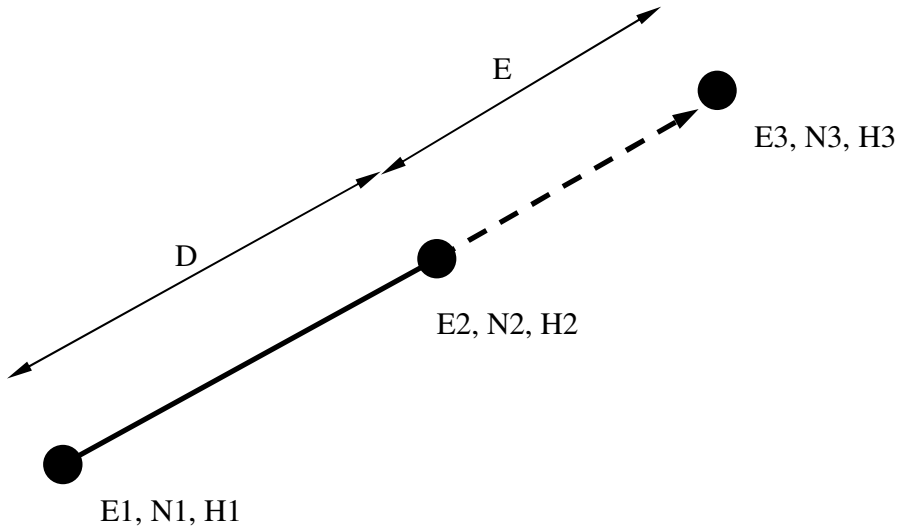
Introduction

Creates a 3-D point in space at a specified further distance along a line defined by two 3-D points. This is useful to co-ordinate a point that is not visible. The program is 2-D if the heights of the two points are the same.

The distance between the two known points is also computed so that a check may be made if the distance is known.

The vector may be extended negatively as well as positively from the second point.

Diagram



Input

2 known points:	(E1, N1, H1) (E2, N2, H2)
Extension of vector:	E

Output

Extended point:	(E3, N3, H3)
Distance between 1-2:	D

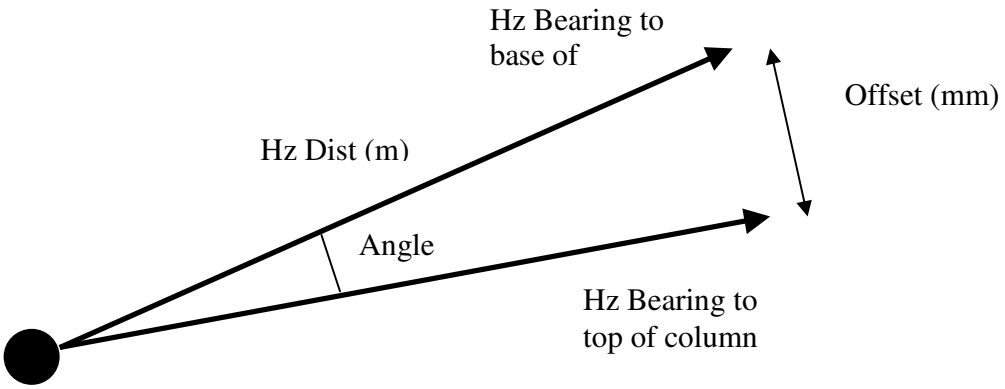
VERTICAL

Introduction

This program calculates the offset of a point given a difference in angle and a distance to the point. This is used to determine the verticality of a column by measuring the difference in horizontal angle at the top to the base and by measuring the horizontal distance to the column.

Since small angles are usually involved, the angle is made up of “minutes” and “seconds” only.

Diagram



Input

Angle:	min, sec
Distance:	m

Output

Offset:	mm

EXAMPLES

The following examples indicate how the programs can be used.

1PT~CFIX

Q: From an instrument set-up at (123.456mE, 234.567mN), the following horizontal angles were measured to the left and right hand sides of a tubular column respectively: 246° 13' 57" and 247° 54' 32". In addition, a horizontal distance of 13.579m was measured to the column at the mid-point of these angles. Calculate the centre co-ordinates and the radius.

A: (110.764mE, 229.198mN) and 0.202m.

2PT~CFIX

Q: Two points were measured on the surface of a circular column. The column is to the LEFT of the points looking from the first to the second.

The radius of the column is known to be 0.406m.

Calculate the centre co-ordinates of the column.

Point	Easting	Northing
1	23.432m	78.234m
2	23.823m	78.765m

A: (23.437mE, 78.640mN).

3D~CFIX

Q: Calculate the centre co-ordinates and radius of a 3D (inclined) circle with the following points on its perimeter.

Point	Easting	Northing	Height
1	80.779m	90.198m	23.567m
2	78.334m	66.990m	25.567m
3	45.345m	67.623m	34.123m

A: (61.890mE, 80.840mN, 29.037mH) and radius 21.778m.

3PT~CFIX

Q: The following co-ordinates were measured around the edge of a circle. Calculate the centre co-ordinates and the diameter.

Point	Easting	Northing
1	23.432m	78.234m
2	45.323m	98.765m
3	67.334m	66.999m

A: (46.217mE, 75.876mN) and 45.814m.

ANGLE

Q: Calculate the clockwise and anti-clockwise angles between the following 3 points. (Point 2 is at the apex).

Point	Easting	Northing
1	80.779m	90.198m
2	78.334m	66.990m
3	45.345m	67.623m

A: 265° 05” 06.9” & 94° 54’ 53.1”

AREA

Q: The corners of a field have the following co-ordinates. What is the total area?

Point	Easting	Northing
1	45.345m	67.623m
2	78.334m	66.990m
3	80.779m	90.198m
4	66.678m	96,786m
5	35.121m	88.009m

Hint: The co-ordinates of the first point must be re-entered at the end to close the loop.

A: 1025.991m².

BRG~DIST

Q: Calculate the bearing and distance between the points (509.456mE, 234.656mN) and (661.443mE 423.565mN).

A: 38° 49' 06.48" and 242.4596m.

CIRCLE

Q: Calculate the nearest East-West offset distance to a circle with centre (108.510mE, 254.523mN) and radius 25m, from a point at 89.020mE, 270.644mN.

Hint: Input Northing.

A: 0.382m (89.402mE – 89.020mE)

COLUMN

Q: The co-ordinates of 2 corners of a column were measured as (345.567mE, 256.323mN) and (345.867mE, 256.325mN). If the column measures 0.355m to the left of these points, calculate the column centre.

A: (345.716mE, 256.501mN).

CURVE

Q: Determine the next 3 points clockwise around a curve at 3m arc distances, on a circle with centre 104.567mE, 345.345mN and with a starting point of 112.879mE, 366.909mN.

A: (115.600mE, 365.652mN), (118.136mE, 364.053mN) & (120.444mE, 362.139mN).

CUT~AREA

Q: A new plot boundary is required parallel to an existing boundary which is 135.978m long, with angles of 103º and 129º at either end. The new area should be 6800m². At what parallel offset should the new boundary be placed.

A: 42.949m.

INT~SECT

Q: The bearings from 2 independent stations: (234.657mE, 544.109mN) and (566.855mE, 607.233mN) were 56° 12' 23" and 294° 56' 54" respectively. Calculate the co-ordinates of the intersected point.

A: (426.519mE, 672.519mN).

INT~SECT2

Q: Calculate the co-ordinates of a point lying on the intersection of 2 lines between the following points:

Line 1 – (234.456mE, 432.654mN) to (342.564mE, 324.465mN)
Line 2 – (789.123mE, 687.109mN) to (987.321mE, 897.091mN)

A: .

LEVELS

Q: A Benchmark with a value of 18.550m, was used for a Backsight reading of 1.710m. Calculate the reduced levels of Foresight Points with readings of 1.347m, 1.365m and 1.450m.

A: 18.913mH, 18.895mH and 18.810mH.

MEAN~XY

Q: Calculate the centre co-ordinates of a column given the co-ordinates of two diagonal corners of (233.434mE, 344.544mN) and (233.826mE, 344.200mN).

A: (233.630mE, 344.372mN).

NOTEBOOK

No calculations are performed in this program.

OFFSET

Q: From a Baseline with end co-ordinates of (109.901mE, 227.810mN) and (110.768mE, 320.912mN), calculate the Offset and Chainage of a measured point at (110.345mE, 270.508mN).

A: 0.046 (to the right) and 42.700m (along the line).POLYGON

POLYGON

Q: Calculate the bearings and distances between the following points:

Point	Easting	Northing
1	23.432m	78.234m
2	45.323m	98.765m
3	67.334m	66.999m
4	66.678m	96,786m

A: 1 to 2: 46°50' 10.35" & 30.0123m, 2 to 3: 145° 16' 53.4" & 38.6466m, 3 to 4: 358° 44' 18" & 29.7942m.

PT2PLANE

Q: A sloping concrete surface has the following co-ordinates at three of its corners, calculate how high the surveyed point is from this surface:

Point	Easting	Northing	Elevation
1	648.851m	885.314m	4.105m
2	650.056m	885.527m	3.756m
3	649.298m	886.012m	3.756m

Surveyed point on concrete: 650.170mE, 885.734mN, 3.638mH

A: 17mm.

RADIAL

Q: Calculate the bearings and distances from Station 1 at co-ordinates (45.678mE, 23.519mN) to the following points:

Point	Easting	Northing
2	23.432m	78.234m
3	45.323m	98.765m
4	67.334m	66.999m.

A: Station 1 to 2: 337° 52' 27" & 59.0645m, Station 1 to 3: 359° 43' 46" & 75.2468m, Station 1 to 4: 26° 28' 35.15" & 48.5746m

RESECT

Q: Calculate the free-station co-ordinates of an instrument observing to the following points (listed in clockwise order):

Point	Easting	Northing
1	1123.457m	345.675m
2	987.650m	157,913m
3	246.810m	213.546m

to which the following arbitrary Horz Angles were observed:

00° 50' 53", 18° 55' 58" and 197° 03' 44" respectively.

A: (500.0128mE, 200.0001mN)

SURVEY

Q: The following information was recorded from an instrument. Use the data to co-ordinate the target. Station co-ordinates: (502.405mE, 789.765mN). Station Reduced Level: 18.900mH. Instrument Height above Station: 1.612m. RO co-ordinates: (578.324mE, 340.822mN). Horz Angle: 233° 44' 55". VA: 88° 33' 22". Slope distance: 45.543m. Target Height: 0.500m.

A: (534.1176mE, 822.4324mN, 21.1596mH)

SURVEY2D

Q: The following information was recorded from an instrument. Use the data to co-ordinate the target. Station co-ordinates: (502.405mE, 789.765mN). RO co-ordinates: (578.324mE, 340.822mN). Horz Angle: 233° 44' 55". Horizontal distance: 45.543m.

A: (534.128mE, 822.443mN)

TRANSFRM

Q: 2 points were arbitrarily co-ordinated as (105.657mE, 194.004mN) and (95.574mE, 209.869mN), from an unknown station with arbitrary instrument co-ordinates of (100.000mE, 200.000mN).

If the two points were known and should have co-ordinates of (300.000mE, 500.000mN) and (318.800mE, 500.000mN) respectively, calculate the true instrument co-ordinates and the true bearing to the second observed point.

A: (308.0957mE, 501.5583mN) and 98° 16' 58.64".

TRAVERSE

Q: From a known baseline of Station 1 (454.545mE, 767.676mN) and an RO with co-ordinates of (878.787mE, 232.323mN), the following Horz Angle and Horz Distance was measured to Station 2: 45° 54' 45" and 121.212m. After moving to this Station, an angle and distance of 289° 08' 23" and 34.434m was measured to Station 3. What are the co-ordinates of Station 3?

A: (407.9134mE, 662.9546mN)

UNI~COLS

Q: Obtain the Web and Flange thicknesses of a 254x254x89 UC.

A: 10.7mm and 17.3mm respectively.

VECTORS

Q: Two points have been co-ordinated as (723.884mE, 184.542mN, 18.567mH) and (732.676mE, 185.409mN, 18.689mH). Calculate the co-ordinates of a third point, if the slope distance from the second point to a third point is 3.075m.

A: (735.736mE, 185.711mN, 18.731mH)

VERTICAL

Q: The difference in the Horz Angle reading to a column edge from its base to the top is 00° 01' 48". If the column is 12m away, calculate the plumb error of the column.

A: 6.3mm.

REVISIONS

Revision	Date	Updated
1.0a	May 2003	Beta revision.
1.1	July 2003	“UC” program added.
1.2	April 2004	“2PT~CFIX” program added.
1.21	May 2004	“OFFSET” description corrected.
1.22	May 2004	“1PT~CFIX” program updated.
1.3	July 2005	“NOTEBOOK” program added.
1.4	November 2005	“ANGLES” program re-named “SURVEY” “ANGLE” program added.
1.5	November 2005	“CIRCLE” program added.
1.6	March 2007	“PT2PLANE” program added.
1.7	November 2007	“SURVEY2D” program added
2.1	August 2008	Introduction extended. “Curve” Program added. “Cut~Area” Program added.
3.0	November 2009	“3D-CFIX” program added. “INT~SECT2” program added.

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