

## Transformation Between Cartesian to Geodetic Coordinates Bowring Method

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Some useful angle functions

$$\text{dd}(\text{ang}) := \left\{ \begin{array}{l} \text{degree} \leftarrow \text{floor}(\text{ang}) \\ \text{mins} \leftarrow (\text{ang} - \text{degree}) \cdot 100.0 \\ \text{minutes} \leftarrow \text{floor}(\text{mins}) \\ \text{seconds} \leftarrow (\text{mins} - \text{minutes}) \cdot 100.0 \\ \text{degree} + \frac{\text{minutes}}{60.0} + \frac{\text{seconds}}{3600.0} \end{array} \right.$$

$$\text{r2d} := \frac{180}{\pi}$$

$$\text{radians}(\text{ang}) := \left\{ \begin{array}{l} \text{d} \leftarrow \text{dd}(\text{ang}) \\ \text{d} \cdot \frac{\pi}{180.0} \end{array} \right.$$

$$\text{dms}(\text{ang}) := \left\{ \begin{array}{l} \text{degree} \leftarrow \text{floor}(\text{ang}) \\ \text{rem} \leftarrow (\text{ang} - \text{degree}) \cdot 60 \\ \text{mins} \leftarrow \text{floor}(\text{rem}) \\ \text{rem1} \leftarrow (\text{rem} - \text{mins}) \\ \text{secs} \leftarrow \text{rem1} \cdot 60.0 \\ \text{degree} + \frac{\text{mins}}{100} + \frac{\text{secs}}{10000} \end{array} \right.$$

Constants for GRS 80:

$$a := 6378137 \quad b := 6356752.3141 \quad e_2 := 0.00669438002290$$


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Given Quantities:

$$X := 472239.0061 \quad Y := -4493054.0133 \quad Z := 4487560.5408$$


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Solution:

$$e_{p2} := \frac{a^2 - b^2}{b^2}$$

$$e_{p2} = 0.0067394968$$

$$\lambda := \text{atan2}(X, Y)$$

$$\text{dms}(\lambda \cdot \text{r2d}) = -84.00000000$$

$$W := \sqrt{X^2 + Y^2}$$

$$W = 4517803.010902$$

The initial estimate of the parameter  $\beta_0$  is

$$\beta_0 := \text{atan}\left(\frac{a}{b} \cdot \frac{Z}{W}\right)$$

$$\beta_0 = 0.7837191028$$

$$\phi := \operatorname{atan} \left[ \frac{Z + e_p^2 \cdot b \cdot (\sin(\beta_o))^3}{W - a \cdot e_2 \cdot (\cos(\beta_o))^3} \right]$$

$$\operatorname{dms}(\phi \cdot r2d) = 45.00000000$$

$$\beta := \operatorname{atan} \left( \frac{b}{a} \cdot \tan(\phi) \right)$$

$$\beta = 0.7837189446$$

$$\operatorname{dms}(|\beta - \beta_o| \cdot r2d) = 0.0000032637$$

The second iteration

$$\beta_o := \beta$$

$$\beta_o = 0.7837189446$$

$$\phi := \operatorname{atan} \left[ \frac{Z + e_p^2 \cdot b \cdot (\sin(\beta_o))^3}{W - a \cdot e_2 \cdot (\cos(\beta_o))^3} \right]$$

$$\operatorname{dms}(\phi \cdot r2d) = 45.00000000$$

$$\beta := \operatorname{atan} \left( \frac{b}{a} \cdot \tan(\phi) \right)$$

$$\beta = 0.7837189446$$

$$\operatorname{dms}(|\beta - \beta_o| \cdot r2d) = 0$$

The end of the iterations

$$H := \frac{W}{\cos(\phi)} - a \cdot \left[ 1 - e_2 \cdot (\sin(\phi))^2 \right]^{\frac{-1}{2}}$$

$$H = 300.000015$$