REVIEW OF VECTOR ALGEBRA

magnitude of a vector is

$$|A| = \sqrt{A_x^2 + A_y^2 + A_z^2}$$

$$A := \begin{pmatrix} 3 \\ 7 \\ 2 \end{pmatrix} \qquad |A| = 7.874$$

unit vector in the direction of A is

$$n_A = \frac{A}{|A|} = n_{Ax} \cdot i + n_{Ay} \cdot j + n_{Az} \cdot k$$

$$\begin{pmatrix} A_x \\ A_y \\ A_z \end{pmatrix} := A \qquad n_A := \frac{\begin{pmatrix} A_x \\ A_y \\ A_z \end{pmatrix}}{|A|}$$

If two vectors A and B are equal, then

$$A_x = B_x \quad A_y = B_y \quad A_z = B_z$$

$$\sqrt{A_x^2 + A_y^2 + A_z^2} = 7.874$$

The scalar (dot or inner) product of two vectors

$$A \cdot B = B \cdot A = A_x \cdot B_x + A_y \cdot B_y + A_z \cdot B_z$$

$$A \cdot B = |A| \cdot |B| \cdot \cos(\theta)$$

$$|n_A| = 1 \qquad n_A = \begin{pmatrix} 0.381 \\ 0.889 \\ 0.254 \end{pmatrix}$$

The vector (cross) product of two vectors

$$A \times B = (|A| \cdot |B| \cdot \sin(\theta)) \cdot I$$

$$|A \times n_B| = |A| \cdot 1 \cdot \sin(\theta)$$

$$A \times B = \begin{pmatrix} i & j & k \\ A_x & A_y & A_z \\ B_x & B_y & B_z \end{pmatrix}$$

Drawing a Tangent-Tangent-Radius Circle :

$$i := 0 .. 10 \qquad R := 30 \qquad P_1 := \begin{pmatrix} 30 \\ 70 \\ 0 \end{pmatrix} \qquad P_2 := \begin{pmatrix} 130 \\ 230 \\ 0 \end{pmatrix} \qquad P_3 := \begin{pmatrix} 50 \\ 150 \\ 0 \end{pmatrix} \qquad P_4 := \begin{pmatrix} 230 \\ 120 \\ 0 \end{pmatrix}$$

$$n_1 := \frac{P_2 - P_1}{|P_2 - P_1|} \qquad n_1 = \begin{pmatrix} 0.53 \\ 0.848 \\ 0 \end{pmatrix} \qquad n_2 := \frac{P_4 - P_3}{|P_4 - P_3|} \qquad n_2 = \begin{pmatrix} 0.986 \\ -0.164 \\ 0 \end{pmatrix}$$

$$P_{1'} = P_1 + R \cdot n_4$$
$$P_{2'} = P_2 + R \cdot n_4$$
$$P_{3'} = P_3 + R \cdot n_5$$
$$P_{4'} = P_4 + R \cdot n_5$$

$$n_3 := \frac{n_1 \times n_2}{|n_1 \times n_2|} \qquad n_3 = \begin{pmatrix} 0 \\ 0 \\ -1 \end{pmatrix} \qquad n_4 := \frac{n_3 \times n_1}{|n_3 \times n_1|} \qquad n_4 = \begin{pmatrix} 0.848 \\ -0.53 \\ 0 \end{pmatrix}$$

$$n_5 := \frac{n_2 \times n_3}{|n_2 \times n_3|} \qquad n_5 = \begin{pmatrix} 0.164 \\ 0.986 \\ 0 \end{pmatrix}$$

$$P_1 + u \cdot (P_2 - P_1) + R \cdot n_4 = P_3 + v \cdot (P_4 - P_3) + R \cdot n_5 \qquad \mathbf{. \, n_5}$$

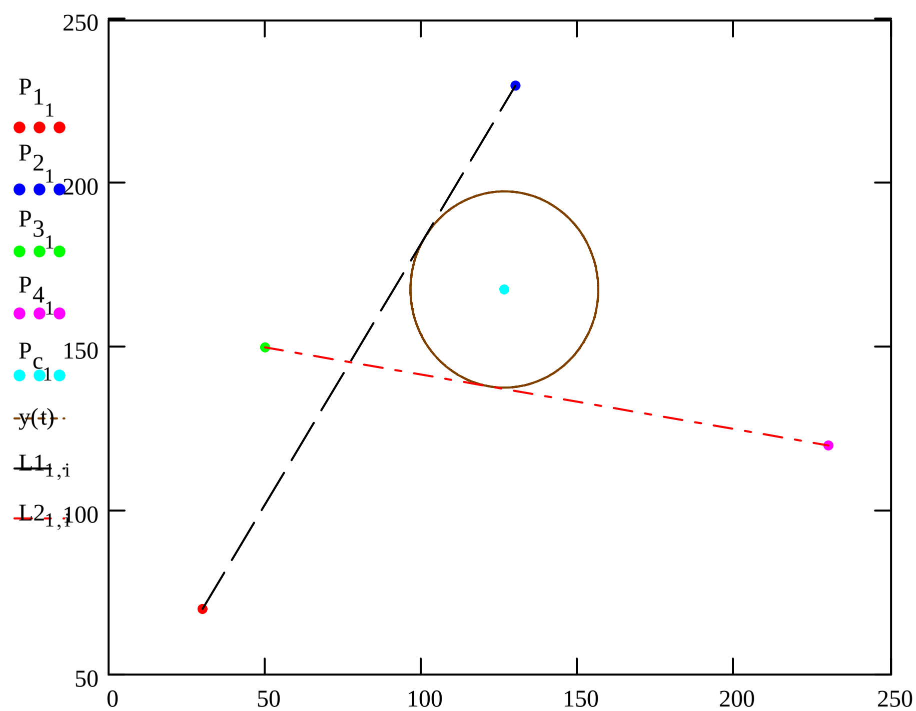
$$u := \frac{(P_3 - P_1) \cdot n_5 + (1 - n_4 \cdot n_5) \cdot R}{(P_2 - P_1) \cdot n_5} \qquad u = 0.71$$

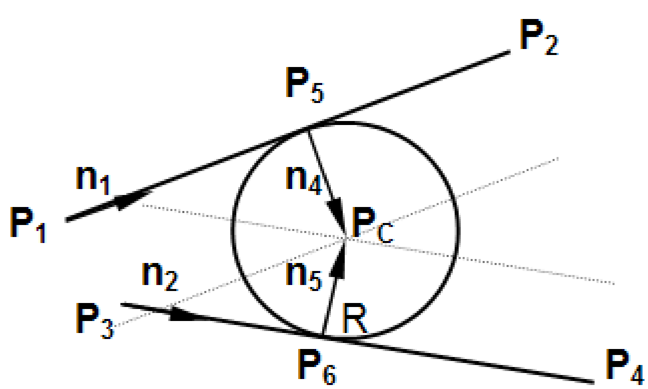
$$P_c := P_1 + u\cdot(P_2 - P_1) + R\cdot n_4$$

$L1_0 := P_1$ $\quad L1_1 := P_2$ $\quad$ Enter x and y coordinate of center: $x_c := P_{c_0}$ $\quad y_c := P_{c_1}$

$$L1 := \begin{pmatrix} P_{1_0} & P_{2_0} \\ P_{1_1} & P_{2_1} \\ P_{1_2} & P_{2_2} \end{pmatrix} \qquad L1 = \begin{pmatrix} 30 & 130 \\ 70 & 230 \\ 0 & 0 \end{pmatrix} \qquad L2 := \begin{pmatrix} P_{3_0} & P_{4_0} \\ P_{3_1} & P_{4_1} \\ P_{3_2} & P_{4_2} \end{pmatrix} \qquad L2 = \begin{pmatrix} 50 & 230 \\ 150 & 120 \\ 0 & 0 \end{pmatrix}$$

Enter radius: $\quad r := R \qquad x(t) := r\cdot\cos(t) + x_c \qquad y(t) := r\cdot\sin(t) + y_c \qquad i := 0 .. 1$





$$(P_c - P_1) \times n_1 = \begin{pmatrix} 0 \\ 0 \\ 30 \end{pmatrix}$$

$$R := \left|(P_c - P_1) \times n_1\right|$$

$$R = 30$$

$$n_x := \begin{pmatrix} 1 \\ 0 \\ 0 \end{pmatrix}$$

DRAWING A FILLET ARC AT THE INTERSECTION POINT OF LINES

Angle between first and horizontal Lines : $\operatorname{acos}(-n_4 \cdot n_x) = 147.995\,\text{deg}$

Angle between two Lines : $\operatorname{acos}(n_1 \cdot n_2) = 67.457\,\text{deg}$

$|n_2 \times n_3| = 1 \qquad |n_3 \times n_1| = 1$

$$\sqrt{\left(n_{5_0}\right)^2 + \left(n_{5_1}\right)^2 + \left(n_{5_2}\right)^2} = 1 \qquad v := \frac{(P_1 - P_3)\cdot n_4 + (1 - n_5 \cdot n_4)\cdot R}{(P_4 - P_3)\cdot n_4} \qquad v = 0.397$$

$$P_{ce} := P_3 + v\cdot(P_4 - P_3)$$

$$P_{cs} := P_1 + u\cdot(P_2 - P_1) \qquad P_{ce} := P_c - R\cdot n_5$$

$$n_{cs} := \frac{P_{cs} - P_c}{|P_{cs} - P_c|} \qquad n_{cs} = \begin{pmatrix} -0.848 \\ 0.53 \\ 0 \end{pmatrix}$$

$$cs := \operatorname{if}\left(0 < n_{cs_1}, \operatorname{acos}(n_{cs}\cdot n_x), \pi + \operatorname{acos}(n_{cs}\cdot n_x)\right)$$

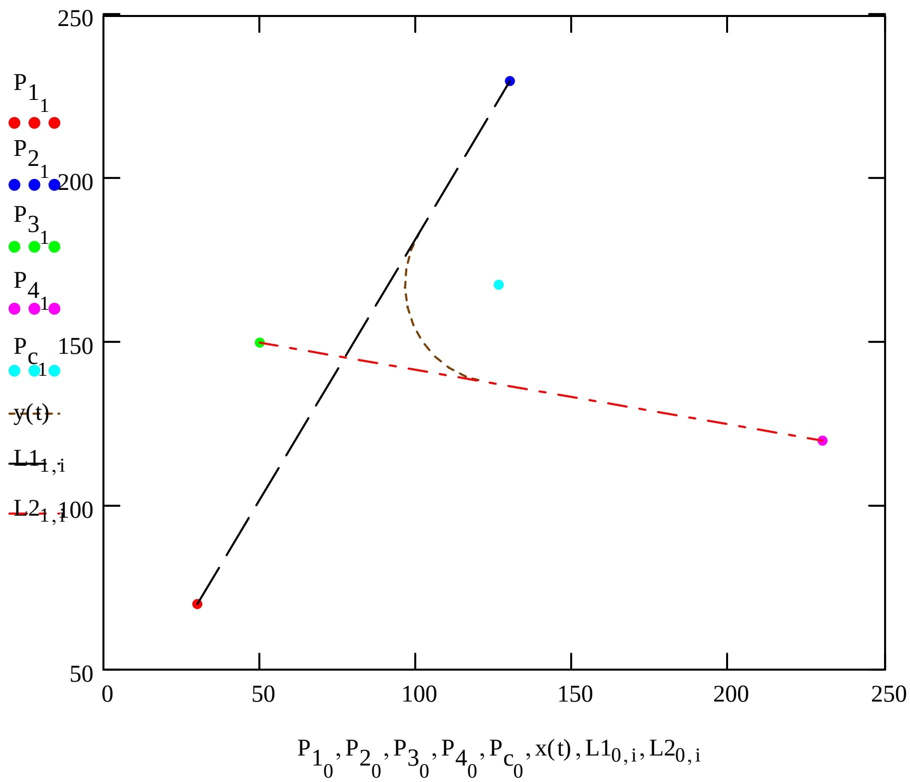
$$cs = 147.995\,\text{deg} \qquad \operatorname{acos}(n_{cs}\cdot n_x) = 147.995\,\text{deg}$$

$$n_{ce} := \frac{P_{ce} - P_c}{|P_{ce} - P_c|} \qquad n_{ce} = \begin{pmatrix} -0.164 \\ -0.986 \\ 0 \end{pmatrix}$$

$$ce := \operatorname{if}\left(0 < n_{ce_1}, \operatorname{acos}(n_{ce}\cdot n_x), 2\cdot\pi - \operatorname{acos}(n_{ce}\cdot n_x)\right)$$

$$ce = 260.538\,\text{deg} \qquad \operatorname{acos}(n_{ce}\cdot n_x) = 99.462\,\text{deg}$$

$$t := cs, cs + \left(\frac{ce - cs}{10}\right) .. ce$$



Offset Parallel Line

Drawing a Tangent-Tangent-Radius Circle :

$d := 3 \qquad P_0 := \begin{pmatrix} 2 \\ 3 \\ 0 \end{pmatrix} \qquad P_1 := \begin{pmatrix} 5 \\ 6 \\ 0 \end{pmatrix} \qquad T := \begin{pmatrix} 1 & 0 & 2 \\ 0 & 1 & 3 \\ 0 & 0 & 1 \end{pmatrix} \qquad T1 := \begin{pmatrix} 1 & 0 & -2 \\ 0 & 1 & -3 \\ 0 & 0 & 1 \end{pmatrix}$

$n_1 := \dfrac{P_1 - P_0}{|P_1 - P_0|} \qquad n_1 = \begin{pmatrix} 0.707 \\ 0.707 \\ 0 \end{pmatrix} \qquad \theta := 90deg \qquad Rz(\theta) := \begin{pmatrix} \cos(\theta) & -\sin(\theta) & 0 \\ \sin(\theta) & \cos(\theta) & 0 \\ 0 & 0 & 1 \end{pmatrix}$

$n_3 := T \cdot Rz(-\theta) \cdot T1 \cdot n_1 \qquad n_3 = \begin{pmatrix} 0.707 \\ -0.707 \\ 0 \end{pmatrix} \qquad n_2 := n_1 \qquad n_2 = \begin{pmatrix} 0.707 \\ 0.707 \\ 0 \end{pmatrix} \qquad n_4 := \begin{pmatrix} 0 \\ 0 \\ 1 \end{pmatrix}$

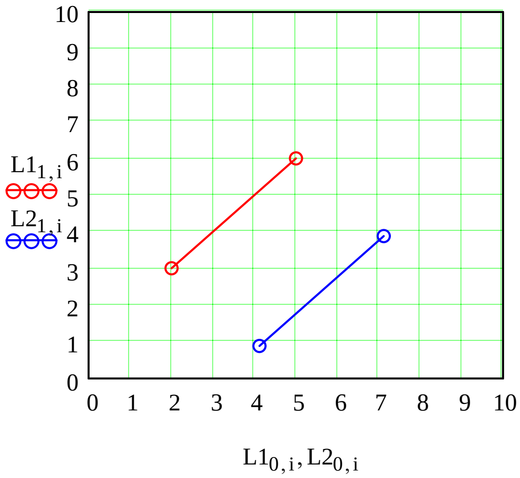
$u := uu$

$u := u$

$n_3 := \dfrac{n_1 \times n_4}{|n_1 \times n_4|} \qquad n_3 = \begin{pmatrix} 0.707 \\ -0.707 \\ 0 \end{pmatrix} \qquad P_2 := P_0 + d \cdot n_3 \qquad P_3 := P_1 + d \cdot n_3$

$p(u) := P_2 + u \cdot (P_3 - P_2)$

$L1 := augment(P_0, P_1) \qquad L2 := augment(P_2, P_3) \qquad p(u) \rightarrow$



$$2+\frac{3}{2}\cdot\sqrt{2}=4.121$$

$$3-\frac{3}{2}\cdot\sqrt{2}=0.879$$

$$P_2=\begin{pmatrix}4.121\\0.879\\0\end{pmatrix}$$

$$P_3=\begin{pmatrix}7.121\\3.879\\0\end{pmatrix}$$