(1) $y = (a^2 + \tan^2\theta * x^2)^{1/2}$

Define
$c = \tan^2\theta$ (a constant)

then,

$dy/dx = ½*(a^2 + c * x^2)^{-1/2}*2*c*x$

$= c*x*(a^2 + c * x^2)^{-1/2}$

Solve for $dy/dx = \tan\alpha = b$, where α is the exit angle of CD,

$b = c*x*(a^2 + c * x^2)^{-1/2}$

Square both sides

$b^2 = c^2*x^2*(a^2 + c * x^2)^{-1}$

then

$c * x^2 = c^2*x^2/ b^2 - a^2$

$a^2 = c^2*x^2/ b^2 - c * x^2$

$a^2 = (c^2/ b^2 – c) * x^2$

$x^2 = a^2/(c^2/ b^2 – c)$

$x^2 = a^2 *b^2/(c^2– c* b^2)$

$x = a *b/(c^2– c* b^2)^{1/2}$

substituting back in our constants,

$x_c = a * \tan(\alpha)/(\tan^4\theta– \tan^2\theta*\tan^2\alpha)^{1/2}$

$x_c = a * \tan(\alpha)/(\tan\theta * (\tan^2\theta – \tan^2\alpha)^{1/2})$

let $d = \tan(\alpha)/(\tan\theta * (\tan^2\theta – \tan^2\alpha)^{1/2})$ and note that d is a function of α & θ alone.

$x_c = a * d$

we want to find a such that $y_c = 1$.

$y_c = (a^2 + \tan^2\theta * (a * d)^2)^{1/2}$

$y_c^2 = a^2 + \tan^2\theta * a^2 * d^2$

$y_c^2 = a^2 * (1 + \tan^2\theta * d^2)$

$a = y_c / (1 + \tan^2\theta * d^2)^{1/2}$

$a = y_c / (1 + \tan^2\theta * \tan^2\alpha / (\tan^2\theta * (\tan^2\theta - \tan^2\alpha)))^{½}$

$a = y_c / (1 + \tan^2\alpha / (\tan^2\theta - \tan^2\alpha))^{½}$

$a = (\tan^2\theta - \tan^2\alpha)^{½} / \tan\theta * y_c$

so

$x_c = (\tan^2\theta - \tan^2\alpha)^{½} / \tan\theta * y_c * \tan(\alpha) / (\tan\theta * (\tan^2\theta - \tan^2\alpha)^{1/2})$

$x_c = y_c * \tan(\alpha) / \tan^2\theta$