1. $C_L = \frac{4\cos\phi}{\sigma'}\left(\frac{a'}{1+a'}\right)\left(1+a'\right)\left(\frac{1-a}{\lambda_r \tan\phi}\right)$

$C_L = \frac{4\cos\phi}{\sigma'}\left(a'\frac{\lambda_r \tan\phi}{1-a}\right) = \frac{4\sin\phi}{\sigma'}\lambda_r\left(\frac{a'}{1-a}\right)$

Note: $a = \frac{\sigma' C_L}{4\sin\phi\tan\phi + \sigma' C_L}$ $\quad a' = \frac{\sigma' C_L}{4\cos\phi - \sigma' C_L}$

$1-a = 1 - \frac{\sigma' C_L}{4\sin\phi\tan\phi + \sigma' C_L} = \frac{4\sin\phi\tan\phi}{4\sin\phi\tan\phi + \sigma' C_L}$

$C_L = \frac{4\sin\phi}{\sigma'}\lambda_r\left(\frac{\sigma' C_L}{4\cos\phi - \sigma' C_L}\right)\left(\frac{4\sin\phi\tan\phi + \sigma' C_L}{4\sin\phi\tan\phi}\right)$

$C_L = \frac{4\sin\phi}{\sigma'}\frac{\lambda_r \sigma' C_L (4\sin\phi\tan\phi + \sigma' C_L)}{(4\cos\phi - \sigma' C_L)(4\sin\phi\tan\phi)}$

$1 = 4\sin\phi\frac{\lambda_r (4\sin\phi\tan\phi + \sigma' C_L)}{(4\cos\phi - \sigma' C_L)(4\sin\phi\tan\phi)}$

$(4\cos\phi - \sigma' C_L)(4\sin\phi\tan\phi) = 4\sin\phi\,(4\lambda_r \sin\phi\tan\phi + \lambda_r \sigma' C_L)$

$16\cos\phi\sin\phi\tan\phi - 4\sin\phi\tan\phi\,\sigma' C_L = 16\lambda_r \sin^2\phi\tan\phi + 4\lambda_r \sin\phi\,\sigma' C_L$

$16\sin^2\phi - 16\lambda_r \sin^2\phi\tan\phi = 4\lambda_r \sin\phi\,\sigma' C_L + 4\sin\phi\tan\phi\,\sigma' C_L$

$16\sin^2\phi\,(1 - \lambda_r\tan\phi) = 4\sin\phi\,\sigma' C_L\,(\lambda_r + \tan\phi)$

$$\boxed{C_L = 4\frac{\sin\phi}{\sigma'}\frac{(1-\lambda_r\tan\phi)}{(\lambda_r + \tan\phi)}}$$

2. 3 blades, $D = 10m$, $\lambda = 7$, $\alpha = 7°$, $B = 3$

$r/R = 0.5$, $C_L = 1$

$\phi = \tan^{-1}\left(\frac{2}{3\lambda_r}\right)$ $\quad \theta_p = \phi - \alpha$ $\quad \theta_T = \theta_p - \theta_{p_0}$

$\theta_{p_0} = (\theta_p)_{tip} - \phi_{tip} - \alpha$

$\phi_{tip} = \tan^{-1}\left(\frac{2}{3\lambda}\right)$. $\quad C = \frac{8\pi r \sin\phi}{3BC_L\lambda_r}$

$\lambda_r = \lambda \frac{r}{R} = 7(0.5) = 3.5$

$\phi = \tan^{-1}\left(\frac{2}{3}(3.5)\right) = 66.8°$ $\quad \boxed{\phi = 10.78}$

$\theta_p = \phi - \alpha = 10.78 - 7 =$ $\quad \boxed{\theta_p = 3.78}$

$\theta_T = \phi - \phi_{tip}$ $\quad \phi_{tip} = \tan^{-1}\left(\frac{2}{3\lambda}\right) = 5.44$

$\theta_T = 10.78 - 5.44 = 5.34$ $\quad \boxed{\theta_T = 5.34}$

$C = \frac{8\pi r \sin\phi}{3BC_L\lambda_r} = \frac{8\pi(5)\sin(10.78)}{3(3)(1)(3.5)} = 0.746\,m$

$\boxed{C = 0.746\,m}$

3. note 3 is Done in matLab.

4. note 4 is Done in matLab