Aero Hw 1

1.3 flat plate, chord = c, aoa = α, constant pressures
$p_u(s) = C_1$, $p_l(s) = C_2$, $C_2 > C_1$ find center of pressure

Without shear, center of pressure should be at $\frac{c}{2}$ since the forces above & below are each constants.

1.4 flat plate, $c = 1m$,

$p_u = 4\times10^4 (x-1)^2 + 5.4\times10^4$
$p_l = 2\times10^4 (x-1)^2 + 1.73\times10^5$
$\tau_u = 288\, x^{-0.2}$
$\tau_l = 731\, x^{-0.2}$

$\left.\begin{array}{l}\\\\\\\\\end{array}\right\} \frac{N}{m^2}$

find: normal & axial forces
lift & drag
leading edge moments
quarter chord moments
center of pressure

$\alpha = 10$
per unit span

$$N' = -\int_{LE}^{TE} (p_u \cos\theta + \tau_u \sin\theta)\, ds_u + \int_{LE}^{TE} (p_l \cos\theta - \tau_l \sin\theta)\, ds_l$$

$$A' = \int_{LE}^{TE} (-p_u \sin\theta + \tau_u \cos\theta)\, ds_u + \int_{LE}^{TE} (p_l \sin\theta + \tau_l \cos\theta)\, ds_l$$

$$M'_{LE} = \int_{LE}^{TE} [(p_u \cos\theta + \tau_u \sin\theta)x - (p_u \sin\theta - \tau_u \cos\theta)y]\, ds_u + \int_{LE}^{TE} [(-p_l \cos\theta + \tau_l \sin\theta)x + (p_l \sin\theta + \tau_l \cos\theta)y]\, ds_l$$

$$x_{cp} = -\frac{M'_{LE}}{N'}$$

$L' = N' \cos\alpha - A' \sin\alpha$
$D' = N' \sin\alpha + A' \cos\alpha$

$M'_{LE} = -\frac{c}{4} L' + M'_{c/4}$

Wrote matlab scripts to calculate most of these let me know if you want to see them

$N' = 1.2233 \times 10^5$
$A' = 1.2738 \times 10^3$

$L = 1.1041 \times 10^5$
$D = 2.0761 \times 10^4$

$M'_{LE} = -5.7833 \times 10^4$

$x_{cp} = 0.5148\ m$

$M'_{c/4} = -3.0232 \times 10^4$