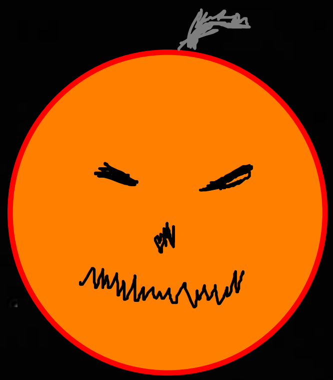

Happy Halloween (today)
and
All-Hallows Day (tomorrow)

AEM 313: Exam 2 C

Name: O'Neill

3rd Nov 2016 | 75 minutes | 6 Pages | Open book, Open notes, Calculator

100 total points

Read, think, plan, and then write.

University of Alabama Academic Honor Pledge:

I promise or affirm that I will not at any time be involved with cheating, plagiarism, fabrication, or misrepresentation while enrolled as a student at The University of Alabama. I have read the Academic Honor Code, which explains disciplinary procedures that will result from the aforementioned. I understand that violation of this code will result in penalties as severe as indefinite suspension from the University.

Signature:__________________________________

Date:______________________________________

(#) x3

(A) B

#	#	#	#

AEM 313: Exam 2 C Name:____________________________

Multiple Choice Problems: Circle **EVERY** correct answer [4 pts each]

AR = 1 ≤ 4 - 5

1. Estimate C_{L_α} at $C_L = 2.0$ for a flat elliptical wing with an aspect ratio of 1 using Prandtl Lifting Line

A. 2π	B. $2\pi/3$	C. $1/\pi$	D. 0.01	E. Not Valid

2. A flat elliptical wing has an aspect ratio of 6. What is C_{D_i} at $C_L = -2.0$? Note the negative lift!

$C_{D_i} = \frac{C_L^2}{\pi AR}$

A. $-2/3\pi$	B. 2122 counts	C. 0	D. 0.106	E. None of the above

3. A flat tapered wing has an aspect ratio of 8 and taper ratio of 0.8. What is C_{D_i} at $C_L = 0.5$?

Lesson 17
$\delta \approx 0.038$
Fig on p.5

A. $1/32\pi$ elliptical only	B. 96 counts elliptical /(δ+1)	C. 0 zero	D. 0.103 elliptical ·(δ+1) shifted by 10	E. None of the above

4. For a subsonic flat linearly tapered wing, which taper ratio gives the lowest induced drag?

Lesson 17
Fig on p 5

1. 0.0	2. 0.35	3. 0.5	4. 1.0	1.5

5. Compute the induced drag described by an upstream velocity of u=10 ft/s at SSL and a downstream velocity defined by:

$$v^2 + w^2 = \begin{cases} x & 0 < x < 1 \quad 0 < y < 1 \\ 0 & otherwise \end{cases}$$

$D = \frac{1}{2}\rho \iint (v^2 + w^2)\, dA$

$= \frac{1}{2}\rho \int_0^1\int_0^1 x \, dx\, dy = \frac{1}{4}\rho$

A. $\pi\rho$	B. 5 counts	C. $\rho/4$	D. $\frac{2\pi}{100}$	E. None of the above

6. Which XFOIL command sequence would simulate an NACA 0012 at Re=60000 at AOA=5?

A. naca 0012 oper visc 60000 alfa 5 hard	B. naca 0012 oper visc 60000 alpha 5	C. load naca0012 ppar 280 oper visc 60000 alpha 5	D. naca 0012 ppar N 280 oper visc 60000 aseq 5	E. None of the above

hard copy spelling sequence

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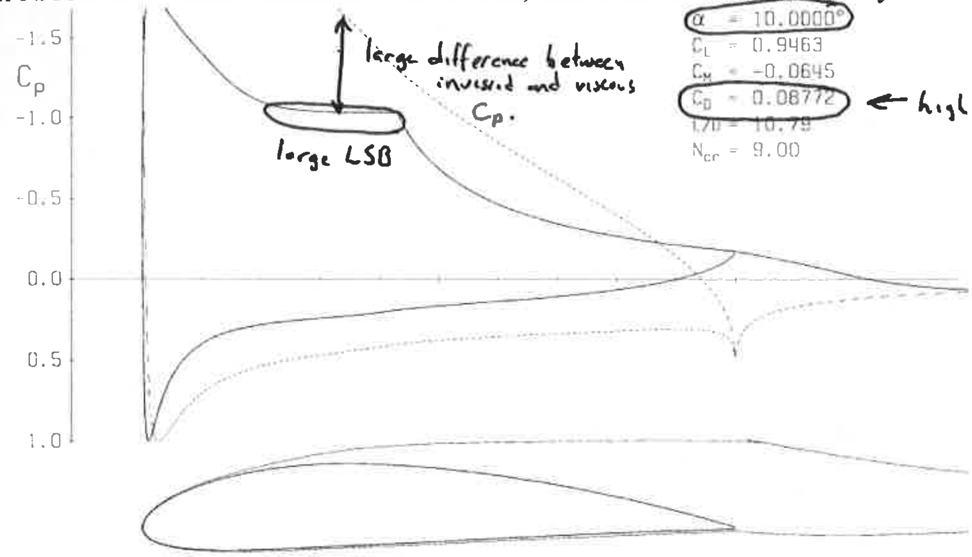
7. For an NACA 4414 airfoil simulated with XFOIL, determine the most likely Reynolds number?



A. Inviscid BL.	B. 60000	C. 600000	D. $6.0 \cdot 10^6$	E. $6.0 \cdot 10^7$

HW was at 200k

8. Where is the shed vorticity in the wake highest?

A. Where Γ is highest	B. At a wing geometry change	C. At the wingtip	D. Where $\lvert d\Gamma / dy \rvert$ is largest	E. None of the above

9. For a delta wing, increasing the leading edge sweep angle from 50 to 70 degrees tends to

A. Increase $C_{L\max}$	B. Increase C_{L_α}	C. Increase induced drag	D. Increase Aspect Ratio	E. Increase the vortex burst AOA

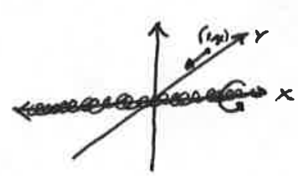
10. For a transport aircraft with flaps up at low altitudes, where are contrails likely to 1st occur?

A. Wing tips	B. Jet exhausts	C. Strakes	D. Wing root	E. Flap tips

11. What is the velocity vector at (x,y,z)=(1,0,1) consistent with an infinite vortex of strength 2π along the x axis (i.e. positive vortex about positive x direction)?

A. (0,0,0)	B. (0,-1,0)	C. (0,1,0)	D. (0,-1/2,0)	E. (0,-0.707,0)

$$V = \frac{\Gamma}{2\pi h}$$



12. Which wing geometries tend to have higher C_l loading near the wing root?

A. Aft swept	B. Forward swept	C. Washout	D. Washin	E. Elliptical wings

13. Circle the phenomena described: Drag due to lift

A. Induced Drag	B. Adverse Yaw	C. Proverse Yaw	D. Aileron Reversal	E. Not possible

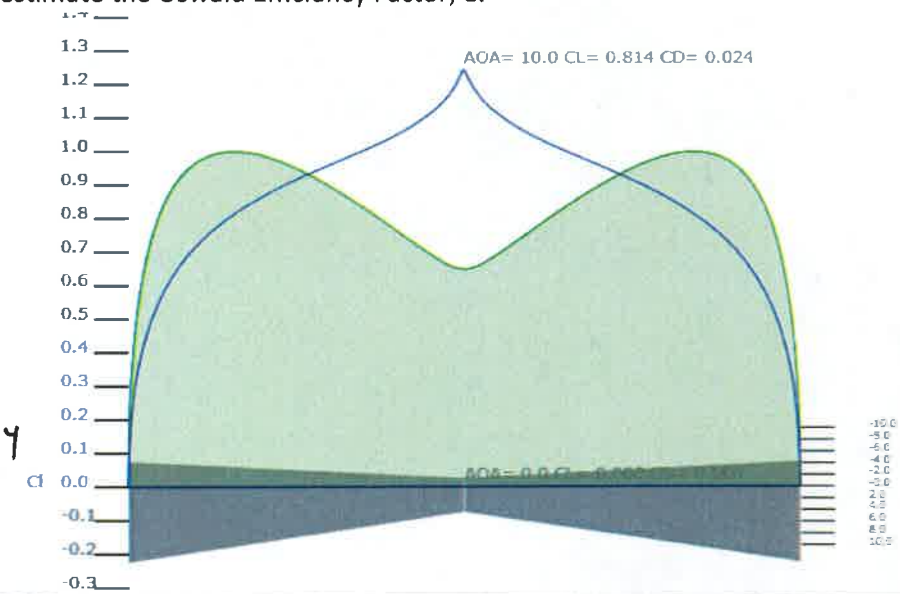
14. If a **flat** non-elliptical $\lambda = 1$ wing is designed to give an Oswald efficiency factor for 1 (i.e. mimicking an elliptical wing), what is true?

A. Not possible	B. airfoil sections must be thicker at the root	C. The wing twist varies with span.	D. The quarterchord downwash is constant.	E. The zero lift line varies with span

15. Given the following lift distribution at AOA=10 for the following AR=10 wing with CL=0.814, CD=0.024 and $\lambda = 3$, estimate the Oswald Efficiency Factor, e.

$$C_D = \frac{C_L^2}{\pi AR e}$$

$$e = \frac{C_L^2}{\pi AR C_D} = \frac{(0.814)^2}{\pi \cdot 10 \cdot 0.024}$$



A. 0.88	B. 0.93	C. 1.08	D. 1.14	E. None of the above

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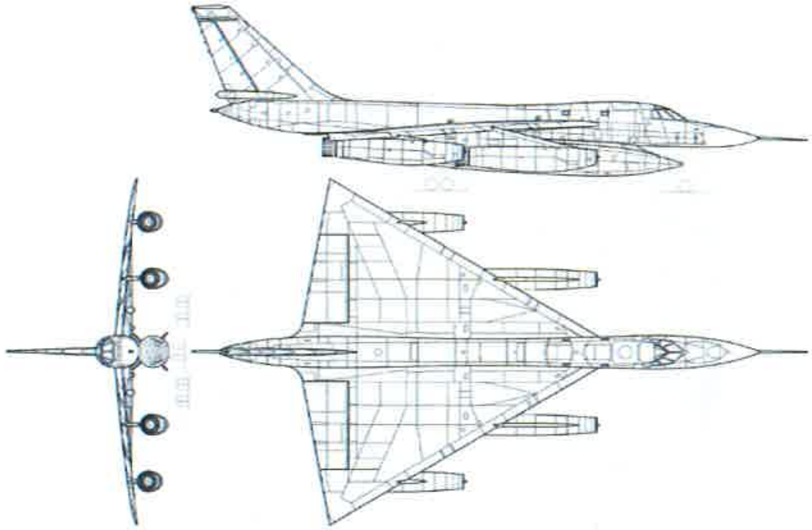
16. [20 pts] Estimate the takeoff speed in ft/s of a B-58 at 150000 lbf at AOA=14 degrees at SSL. The leading edge sweep is 60°. The aspect ratio is 2.09. The wing area is 1542 sq-ft. Hint: V>200mph



(5)

$K_p \approx 2.25$

$K_v \approx 2.9$

$C_L = K_p \sin\alpha \cos^2\alpha + K_v \cos\alpha \sin^2\alpha$

(5)

$= 2.25 \sin 14° \cos^2 14° + 2.9 \cos 14° \sin^2 14°$

$= 0.677$

(5)

$L = W = \bar{q} S C_L = \frac{1}{2}\rho V^2 S C_L$

$V^2 = \frac{2W}{\rho S C_L} \Rightarrow V = \sqrt{\frac{2W}{\rho S C_L}}$

$V = \sqrt{\frac{2 \cdot 150000 \text{ lbf}}{} \bigg| \frac{\text{ft}^2}{0.00237 \text{ slugs}} \bigg| \frac{}{1542 \text{ ft}^2} \bigg| \frac{}{0.677} \bigg| \frac{\text{slugs ft}}{\text{lbf s}^2}}$

(5)

$V = 348 \text{ ft/s}$

$\approx 240 \text{ mph}$

AEM 313: Exam 2 C Name:______________________

17. [20 pts] Estimate the lift coefficient of a thin cambered airfoil at AOA=0. The airfoil is composed of two linear parts. The maximum camber is 10% at the quarterchord.

$x = \frac{c}{2}(1-\cos\theta)$

Short method?

Lesson 13 slat-flap

(5)

$\theta_{sf} = \text{acos}\left(1-2\frac{x}{c}\right) = \text{acos}(1-2\cdot 0.25) = 1.047 \text{ rad}$ $= \pi/3$

(5)

$\delta_s = \text{atan}\left(\frac{10}{25}\right) = +0.38$

$\delta_f = \text{atan}\left(-\frac{10}{75}\right) = +0.13255$

(10)

$C_L = 2\pi\alpha + 2\pi\delta_f\left(1 - \frac{\theta_f}{\pi} + \frac{\sin\theta_f}{\pi}\right) + 2\pi\delta_s\left(-\frac{\theta_s}{\pi} + \frac{\sin\theta_s}{\pi}\right)$

(5)

$= 2\pi\cdot 0 + 2\pi \cdot (+0.13255)\left(1 - \frac{1.047}{\pi} + \frac{\sin 1.047}{\pi}\right) + 2\pi\, 0.38\left(-\frac{1.047}{\pi} + \frac{\sin 1.047}{\pi}\right)$

$= 0.647$

(5) Traditional Method

$\frac{dz}{dx} = \frac{10}{25}, \quad -\frac{10}{75}$ (+5)

$\theta = \text{acos}(\cdots) = 1.047$

(5)

$A_0 = \alpha - \frac{1}{\pi}\int_0^{\pi}\frac{dz}{dx}d\theta = \alpha - \frac{1}{\pi}\int_0^{1.047} \frac{10}{25}\, d\theta - \frac{1}{\pi}\int_{1.047}^{\pi} \left(-\frac{10}{75}\right) d\theta$ ($\frac{10}{25} = 0.4$, $-\frac{10}{75} = -0.1333$)

$= \alpha - \frac{1}{\pi}(1.047) + \frac{1}{\pi}(\pi - 1.047)$

$= \alpha - 0.0444$

(5)

$A_1 = \frac{2}{\pi}\int_0^{1.047} \cos\theta\, d\theta + \frac{2}{\pi}\int_{1.047}^{\pi} \cos\theta\, d\theta$

$= \frac{2\cdot \frac{10}{25}}{\pi}(\sin 1.047 - \sin 0) + \frac{2\left(-\frac{10}{75}\right)}{\pi}(\sin\pi - \sin 1.047) = 0.294$

(5)

$C_L = 2\pi(-0.0444) + \pi(0.294) = \boxed{.645}$