AEM 313: Exam 2 C   Name: O'Neill

Rush Grading?

1st Nov 2017   50 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:____________________________________

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

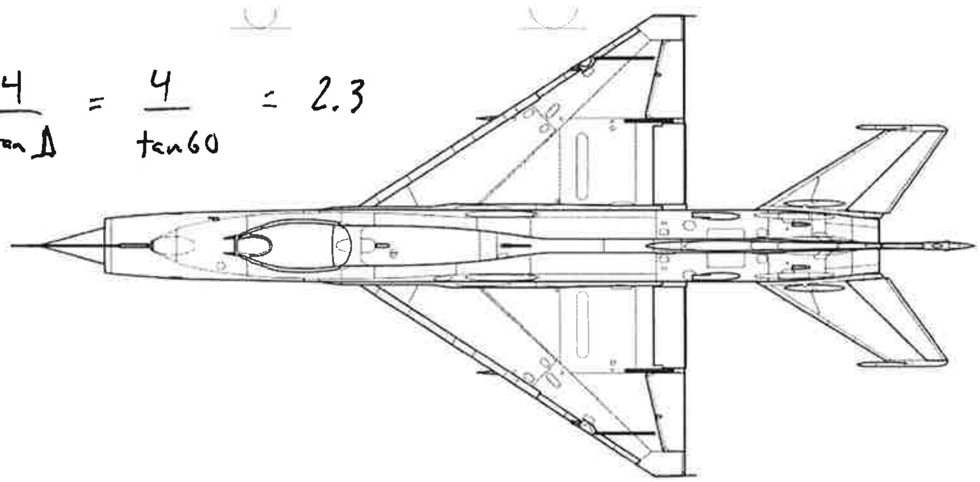
$C_D = \frac{C_L^2}{\pi AR} = \frac{1.0^2}{\pi\ 10}$

1. An elliptical wing has an AR of 10. Estimate the induced drag at CL=1.0.

$\pi/10$	$1/10\pi$	$10/\pi$	$1/\pi$	2π

2. Estimate the maximum lift coefficient of a MiG-21 with a 60 degree LE sweep wing.

$AR = \frac{4}{\tan\Lambda} = \frac{4}{\tan 60} = 2.3$



0.92	1.05	1.18	1.95	None of the above

3. Write down how you would calculate the local lift coefficient (Cl) given the local lift distribution (Γ), the flight velocity (V), and the local chord (c).

$C_\ell = \frac{2\Gamma}{Vc}$

$C_\ell = \frac{L' = \rho V \Gamma}{\frac{1}{2}\rho V^2 c} = \frac{2\Gamma}{Vc}$

4. According to the Helmholtz vortex theorems, a vortex must not terminate. How is this consistent with our theoretical wake vortex extending to infinity?

Vortex lumping	Zero lift	Strength reduction	Closed ring	Not consistent

$C_L = \frac{2\pi}{1+\frac{2\pi}{\pi 8}1.05}$ $T = 1.05$

5. Roughly estimate C_L at AOA=10 degrees for a flat AR=8 wing of taper ratio 0.35 with a symmetrical airfoil.

0.835	0.860	4.78	47.9	Not Valid

6. Estimate the lift coefficient slope (Clα) of a thin airfoil at AOA=0 with a 30% simple flap at 30 degrees deflection. Note, this is NOT a Fowler flap.

0.0	2.17	3.23	4.15	None of the above

7. Circle the phenomena described: Drag due to velocities in the Treffz Plane.

Induced Drag	Adverse Drag	Proverse Yaw	CDo	Elliptical Wing

8. For a transport aircraft at 42000 ft, where are contrails likely to 1st occur?

LEX	Flap tips	Jet exhaust	Wing tips	Wing root

9. For a modern jet powered military fighter aircraft (e.g. F16 or F18) in a tight maximum-performance loop, where might contrails 1st appear?

LEX	Flap tips	Jet exhaust	Wing tips	Wing root

$e = \frac{1}{1.09}$ 0.09

10. A flat tapered wing has a taper ratio of 1.0 and an AR of 10. Estimate the Oswald efficiency term e.

0.09	0.12	0.22	1.09	1.22

11. What is a good reason for using a LEX on a military fighter jet?

Less drag	Higher Operating CL	Visible Contrail Generator	Increased Stability	Higher L/D ratios at low AOA

12. Describe the control deflection consistent of a wing lift distribution with $A_1>0.0$ and $A_2>0.0$ and all other A terms equal to zero.

Ailerons deflected	Spoilers deflected	Flaps deflected	Strakes deployed	Rudder deflected

13. For the same density, weight, and wing area, reducing the stall speed from 100 knots to 50 knots requires an increase in CLmax from 1.0 to ________

0.50	1.25	1.50	2.0	50.0

14. A wing with zero taper tends to initiate stall at the following location

Root	Flap tip	Midspan	Wing tip	Does not stall

15. A particular 2D airfoil stalls exactly at 15 degrees AOA with Cl=2.2. Estimate the wing's AOA where an **elliptical** AR=8 wing using this airfoil would initiate stall. (Challenge problem)

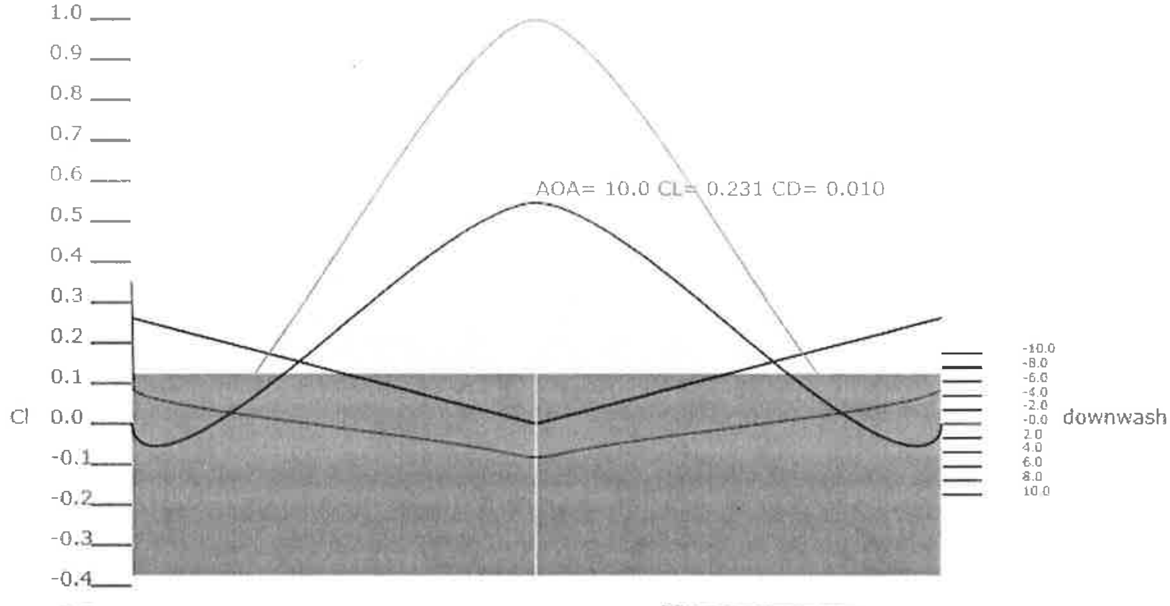
5.0	10.0	15.0	20.0	Does not stall

16. Circle the phenomena described by: yaw moment due to asymmetrical lift

Induced Drag	Adverse Yaw	Aileron Reversal	Vortex Generator	Not Possible

$$\alpha_i = \frac{C_l}{\pi AR} = \frac{2.2}{\pi \cdot 8} = 5^\circ$$

17. For the following AR=4 wing, the pilot is complaining of a poor wing Oswald efficiency factor (e). Circle the change that will improve e .



Increase tip chord	Increase washout	Decrease tip camber	Increase AOA	Deploy inboard spoilers

18. Circle the phenomena described by: yaw moment due to asymmetrical lift

Induced Drag	Adverse Yaw	Aileron Reversal	Vortex Generator	Not Possible

19. The subsonic wing's $C_{L\alpha}$ magnitude is __________ the airfoil's $C_{l\alpha}$ magnitude.

Less than	Equal to	Greater than	2π	Not enough information

20. Which command in XFOIL would allow you to specify the number of surface panels?

pset	tfac	oper	ppar	npanel

21. Your boss asks you to use prl2 to optimize a wing's twist for minimum drag given a specified AR and taper ratio. Discuss the process and any additional information you need.

I need an operating C_L. Vary the tip twist in the text file until the drag is minimized. Iteration.

22. Compute the **induced drag** of a swirling flow of radius 1 with the following velocities

$$u = \begin{cases} 0.9V_\infty & r<1 \\ 0 & otherwise \end{cases}$$

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

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

$\frac{1}{2}\rho \cdot 1 \cdot \pi$

		$\frac{1}{2}\rho\pi$		

23. An infinite vortex filament exists along the z-axis. Which location (dl) of the vortex contributes the most velocity component (dV) at a point (x,y,z)=(1,0,0)?

Negative Infinity	(0,0,0)	Equally	(0,0,1)	Positive Infinity

24. For a single element airfoil vortex-panel solution, where is the **no-flow condition** applied?

Every where	Leading Edge	Quarter Chord	Half Chord	Trailing Edge	None of the Above

25. In your own words, discuss why wings create lift. Include specific physics details such as the shed vorticity, continuity of mass/momentum/energy, and the Kutta condition. Graded based on information not length.

Wings create lift by creating a pressure differential top to bottom. As this Δp requires the conservation of mass and momentum, the unique flow field consistent with this pressure difference has shed vorticity along the flight path. Generation of the Δp requires a sharp TE with the Kutta condition