27th Sept 2017   50 minutes   5 Pages   Open book, Open notes, Calculator, Ruler

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.
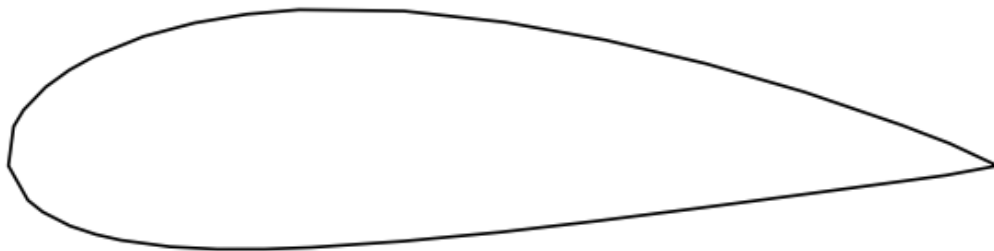
Signature:_____

Date:_____

Multiple Choice Problems: [5 pts each]

1. A blob of fluid with vorticity $\omega = 1$ in the x-direction (i.e. $\omega = 1\hat{x} + 0\hat{y} + 0\hat{z}$) encounters accelerating flow in the x-direction (i.e. $V = x^3\hat{x}$). What happens to the vorticity magnitude?
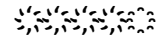
Increases	Nothing	Decreases	Changes direction	Exponentially decays to zero

2. Given the following airfoil, estimate the zero lift AOA in degrees.

3. What is the divergence of a 2D flow with $V = x\hat{i} + xy\,\hat{j} + z^2\hat{k}$ at z = 0 and x = -1?

0	1/2	1	y	None of the above

4. For an NACA 64_3-418 airfoil at Re=6 million, what is the drag coefficient at +6 degrees AOA? The experimental data is plotted below (source: Theory of Wing Sections)

60 counts	140 counts	80 counts	95 counts	None of the above

5. What is the wingspan of a wing with: 250 square foot area, AR=10, and zero taper ratio?

2500	50	35	25	0

6. For a 2D thin airfoil, what is the slope of the lift coefficient curve $dC_l/d\alpha$ [1/rad]?

0 deg	$1/\pi$	$4\sin^2(\alpha)\cos(\alpha)$	2π	None of the above

7. Estimate the SSL stall speed of a Fokker Triplane (S=201 ft^2, W=1300 lbf) given the maximum lift coefficient is 2.2.

35 ft/s	45 mph	50 ft/s	55 ft/s	2480 ft/s

8. An NACA 4321 has a _____

Thickness of 4%	Max Camber of 3% c	Max camber at 21% c	Max Thickness at 30% c	Max camber at 40%

9. What is the air density in slug/ft^3 at 80° F and 14.7 psi?

10. In an incompressible flow at time t=0, you create a timeline-streakline box A at the freestream velocity. At a future time t=1, the box has distorted to box B. Compute the average pressure coefficient at B.
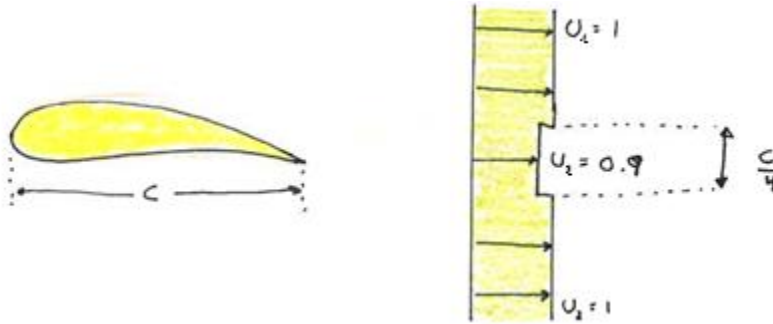

V_∞

A

B

0	0.96	-7.3	-2π	None of the above

11. Given a 26% thick symmetrical Joukowski airfoil at 10 degrees AOA, estimate C_l ?

1.26	2π	$2\pi \cdot 1.15$	$2\pi \cdot 1.18$	72.5

12. An airfoil with a chord of "c" creates a uniform velocity of 0.9 with a thickness of c/4. The upstream velocity is U_1=1. Determine the sectional drag coefficient C_d .

13. What is the temperature at 10000 ft on a standard day?

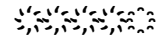| 10 F	23 F	59 F	223 F	483 F

14. Compute the velocity vector at x=1 and y=0 for the streamfunction

$$\psi(r,\theta) = V_\infty r \sin(\theta)\left(1 - \frac{1}{r^2}\right)$$

15. What is the Reynolds number of a 10 inch airfoil operating at SSL and 100 ft/s?

16. An aircraft is rotated to the following Euler angles: $\psi = 0$, $\theta = 90°$, $\phi = 90°$. Compute the angle of attack.

0 deg	45 deg	90 deg	180 deg	None of the above

17. How does increasing camber affect the lift generation at a constant AOA (e.g. 0 degrees)?

No effect	Increases Cl	Decreases Cl	Increases the Lift Slope C_{l_α}	None of the above

18. Fundamentally, why do airfoils generate lift with a lift curve slope of 2π ?

2π is arbitrary	Thickness	Sharp TE	Kutta Joukowski $\rho V \Gamma$	I don't know

19. Determine which airfoil has the most negative Cm

20. Identify the following aircraft part **exactly** by name. This is the part with the letters AH applied.

NACA 64_3-418 Wing Section (*Continued*)

NACA 64_3-418 Wing Section