AEM 313: Practice Exam 2 Name:_____

25th Oct 2016 75 minutes 6 Pages Closed books, Closed 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 **EVERY** correct answer [3 pts each]

1. A flat elliptical wing has an aspect ratio of 8. What is $C_{L_\alpha}$ ?

| | | | | |
|---|---|---|---|---|
| A. | B. | C. | D. | E. None of the above |

2. A flat elliptical wing has an aspect ratio of 8. What is $C_{D_i}$ at $C_L = 0.5$ ?

| | | | | |
|---|---|---|---|---|
| A. | B. | C. | D. | E. None of the above |

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

| | | | | |
|---|---|---|---|---|
| A. | B. | C. | D. | E. None of the above |

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

| | | | | |
|---|---|---|---|---|
| 1. 0.0 | 2. 0.3 | 3. 0.5 | 4. 1.0 | 1.5 |

5. Compute the induced drag described by an upstream velocity of u=1 at SSL and a downstream velocity defined by:

v^2

$$u^2 + w^2 = \begin{cases} 0.1 & r^2 < 1 \\ 0 & otherwise \end{cases}$$

| | | | | |
|---|---|---|---|---|
| A. | B. | C. | D. | E. None of the above |

5. Why is the lift distribution $\Gamma(y) = y$ not physically possible for a finite wing of span b=1?

| | | | | |
|---|---|---|---|---|
| A. Negative Γ | B. Not elliptical | C. Asymmetrical | D. Infinite velocities | E. None of the above |

6. Determine the lift coefficient of a wing of span b=2 given the following bound vortex distribution:

$$\Gamma(y) = \cos\left(\pi \frac{y}{b}\right)$$

| | | | | |
|---|---|---|---|---|
| A. | B. | C. | D. | E. None of the above |

7. Why do increasing lengths of contrails indicate the increasing possibility of stormy weather?

| | | | | |
|---|---|---|---|---|
| A. Combustion provides ionic paths for lightning | B. Vortices create an unstable atmosphere | C. Contrails increase atmospheric heating | D. Atmospheric moisture is increasing | E. None of the above |

8. In the following figure, where is the shed vorticity in the wake highest?

| | | | | |
|---|---|---|---|---|
| F. Combustion provides ionic paths for lightning | G. Vortices create an unstable atmosphere | H. Contrails increase atmospheric heating | I. Atmospheric moisture is increasing | J. None of the above |

9. A finite wing with AR=10 has the following Fourier coefficients. What is the lift coefficient?

$$A_n = 0.1^n \cos(n\pi)$$

| | | | | |
|---|---|---|---|---|
| A. | B. | C. | D. | E. |

10. In a panel method for an airfoil, where are numerical instabilities most likely to occur?

| | | | | |
|---|---|---|---|---|
| A. Trailing Edge | B. Leading Edge | C. Freestream | D. Maximum thickness | E. None of the above |

11. Where is the theoretical aerodynamic center of a flying wing?

| | | | | |
|---|---|---|---|---|
| A. Neutral point | B. Half chord | C. Quarter Chord | D. Leading edge | E. None of the above |

12. For a delta wing, increasing AOA tends to move the vortex burst point

| | | | | |
|---|---|---|---|---|
| A. Forward | B. Aft | C. Outboard | D. Below the wing | E. Does not move |

13. For attached flow over an NACA 0012 airfoil, where is the vorticity concentrated?

| | | | | |
|---|---|---|---|---|
| A. Everywhere | B. Quarter Chord | C. Wake | D. Near the surface | E. Nowhere. Zero vorticity |

14. For a high speed aircraft at high altitudes, where are contrails likely to 1st occur?

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

15. What is the velocity imposed by a semi-infinite vortex of strength 1 at a distance h=1?

| A. | B. | C. | D. | E. |
|---|---|---|---|---|

16. Which wing geometries tend to have higher $C_l$ loading near the wingtips?

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

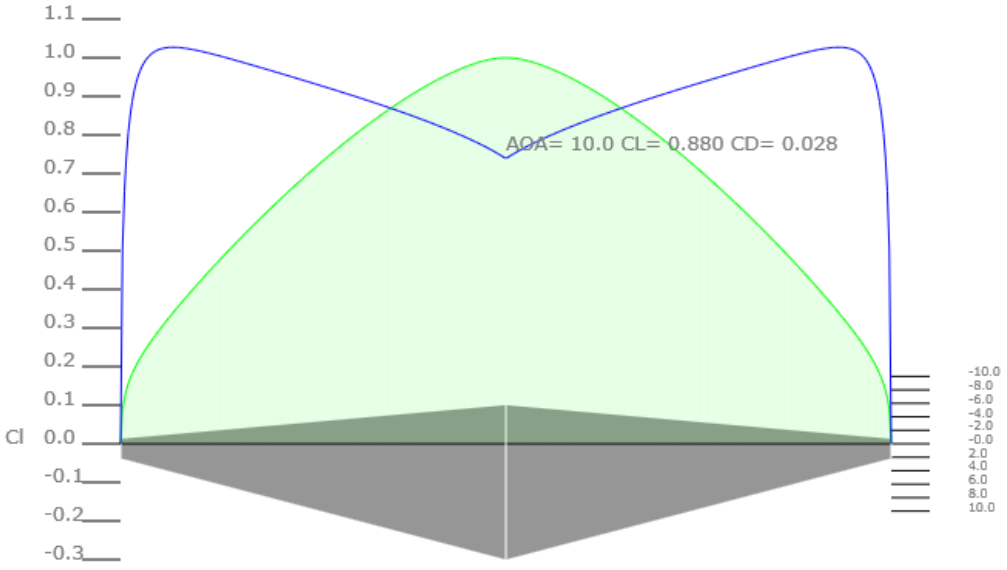
17. Circle the phenomena described: A positive roll moment creates an opposite yaw moment.

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

18. Circle the Helmholtz vortex filament theorems

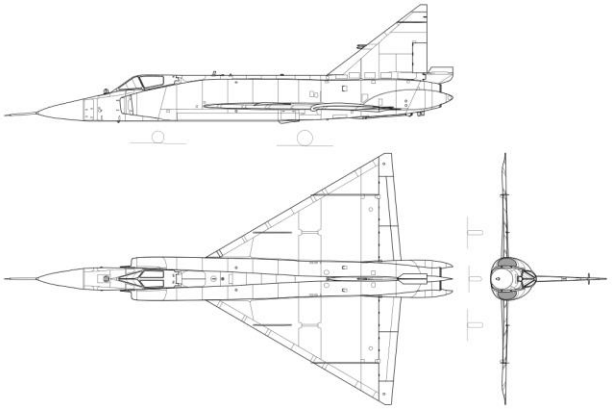
| A. Constant filament strength | B. Filaments never end within a fluid | C. Filaments convect downstream | D. Filaments shapes remain constant | E. Filaments decay exponentially |
|---|---|---|---|---|

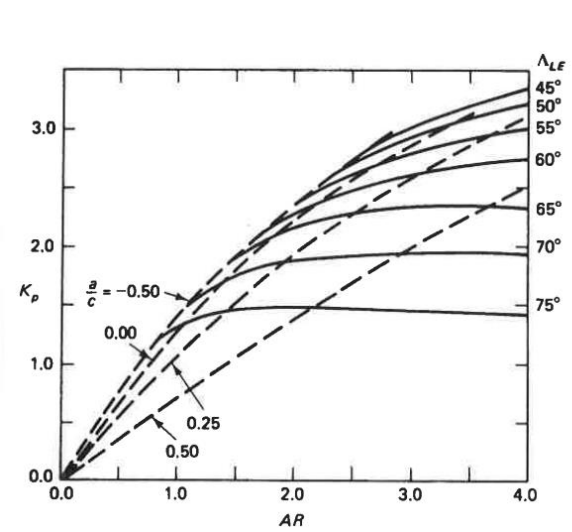
19. Given the following lift distribution at AOA=10 degrees, which wing modifications are likely to improve flight performance and pilot workload during high AOA maneuvers near stall? Assume that the airfoil section has a maximum lift coefficient of $C_{l\max} = 1.1$

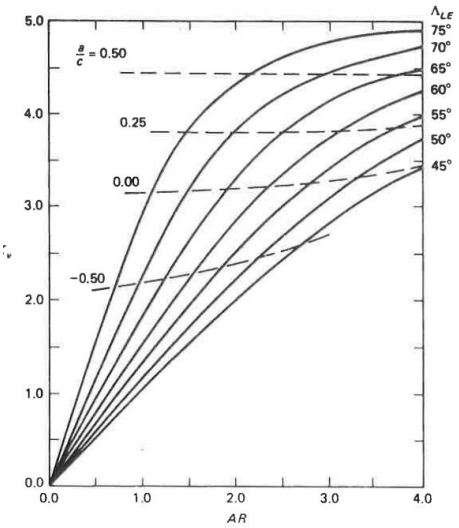



| A. Washin | B. Washout | C. Aft sweep | D. Decrease the taper ratio | E. Inboard spoilers deflected 10 degrees |
|---|---|---|---|---|

20. Estimate the lift to drag ratio (CL/CD) of an F-102 Delta Dagger at AOA=35 degrees?






| A. | B. | C. | D. | E. |
|---|---|---|---|---|
| | | | | |

21. [20 pts] Estimate the lift, drag, and moment of a thin cambered airfoil at AOA=0. The airfoil is composed of two linear parts. The maximum camber is 10% at the midchord.

22. [20 pts] The Prandtl Lifting Line theory for a non-elliptical wing's induced drag is:

$$C_{Di} = \frac{C_L^2}{\pi \cdot AR \cdot e}$$

Given the following Fourier coefficients for a tapered wing of aspect ratio 10, compute the efficiency facter "e".

| n | An |
|---|---|
| 1 | 0.0228 |
| 2 | 0.0000 |
| 3 | -0.0031 |
| 4 | 0.0000 |
| 5 | 0.0016 |
| 6 | 0.0000 |
| 7 | -0.0002 |
| 8 | 0.0000 |
| 9 | 0.0003 |
| 10 | 0.0000 |
| 11 | -0.0001 |
| 12 | 0.0000 |