AEM 313: Practice Final Exam Name:_____

9th Dec 2016 150 minutes ? Pages Open book, Open notes, Calculator

8:00am – 10:30am

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:_____

Practice Problems:

1. What is aerodynamics?
2. What is low speed aerodynamics?
3. Given an airfoil shape, discuss design/application.
4. Airfoil terminology: camber, chord, chord, etc
5. Wing Terminology: b,S,AR,taper,MAC, etc
6. Aircraft Terminology: port, starboard, FS,BL,WL, horizontal stabilizer, elevator, aileron, etc.
7. Lift, Drag, Normal force, Axial force
8. Transformation between wind and body frame
9. Compute ideal gas relations (P=rho R T)
10. What is dry air? Wet air? Density of wet air?
11. Air properties in standard atmosphere? Pressure at 10 kft ~ 10 psi.
12. Which flow regimes are studied in Aero I (this class)? Subsonic, transonic. Identify image.
13. Integrated forces (Lift Drag) from surface pressures and stresses
14. Conservation laws: mass, momentum
15. Lagrangian vs Eulerian frame for conservation laws. D()/Dt = d()/dt + V dot gradient()
16. What non-dimensional terms are important for characterizing fluid flow? Mach, Re, Pr, Ideal Gas
17. Given a downstream wake, compute the drag. (Exam #1 question)
18. Given pressure coefficient on wind tunnel wall, compute the lift.
19. Momentum deficit for full aircraft. Lesson 6 page 12.
20. Define vorticity. Describe vorticity. How is vorticity created? Transported? Destroyed?
21. Circulation is the integral of vorticity. Compute based on vorticity.
22. Kelvin's theorem for conservation of circulation. Assumptions?
23. Flow visualization: define pathline, streakline, timeline, streamline.
24. Given a flow field equation (u,v) determine streamlines.
25. What is a streamfunction? Definition? Physical interpretation of ψ values and contours?
26. Describe elementary flows with streamfunctions. Uniform flow, source, sink, circle flow, etc
27. Identify elementary flows from equations. Which term represents which flow?
28. What is the D'Alembert paradox? What is the solution to the paradox?
29. Lift generated by circulation. Kutta-Joukowski theorem.
30. Given a set of elementary vorticies, can you determine the total lift generated?
31. What is a Joukowski transform? From/To? Circle to airfoil.
32. How does the trailing edge contribute to lift? How does this correspond to the Joukowski airfoil?
33. Compute Cl, Cm, Cd from a specified geometry using Joukowski theory.
34. What is Cl_α for a Joukowski airfoil? How does Cl_α and A.C. vary with camber and thickness?
35. Why might the variation in Cl_α with thickness NOT actually occur in an actual airfoil? Is viscosity a term in the Joukowski theory?
36. Discuss how to use XFOIL
37. Where is vorticity concentrated in aerodynamic flows? Wake and BL
38. What are the assumptions of thin airfoil theory? Governing equations?
39. Given a mean camber line function, calculate Cl, Cm.

40. What is Cl_α for thin airfoil theory? Where is the aerodynamic center for a thin airfoil?
41. What does aerodynamic center mean? Why do we use AC rather than center of pressure?
42. How does thickness affect Cl_α for thin airfoils?
43. Using thin airfoil theory, describe the impact of slats and flaps on an airfoil's performance. Why do flaps and slats behave differently (Kutta condition applied to flaps TE). Lesson 13 part 4.
44. What is a panel method?
45. Why do contrails and/or vapor trails occur?
46. What is the Biot Savart law? What physics does it model? What are the assumptions?
47. Compute the "induced" velocity due to a vortex filament of a certain length.
48. Give 4 Helmholtz Vortex Theorems. Discuss what each on means.
49. What are the assumptions of the Prandtl Lifting Line Theory.
50. Why must the vorticity at a wingtip be zero?
51. Calculate the shed vorticity given a spanwise lift distribution.
52. What is an elliptical lift distribution?
53. Which lift distribution gives the lowest induced drag.
54. What geometric or airfoil properties impact the lift distribution?
55. Given an arbitrary wing geometry, how would lift and drag be computed?
56. Given a wing geometry, compute the lift and drag.
57. Identify lift distributions corresponding to different wing geometries and control deflections.
58. Given a wing geometry near the ground, compute the lift and drag. Ground effect.
59. Determine the drag force and power transferred to the air.
60. Is there an optimal taper ratio for a given AR?
61. How is adverse yaw generated?
62. What is a Trefftz plane? How can you determine induced drag from the downstream velocities?
63. How does wing sweep affect lift distribution at low speeds?
64. Describe the flow properties of a delta wing.
65. Compute lift and drag for delta wing of a given geometry.
66. What is vortex bursting?
67. What effects of vorticity are common for aerodynamics?
68. Describe viscous decambering? Given a boundary layer thickness plot of an airfoil, estimate Cl and Cm.
69. Compute the properties of a Blasius boundary layer.
70. What is the shape of a Blasius boundary layer? Is the BBL laminar or turbulent?
71. Given a flat plate, determine the skin friction coefficient and friction drag.
72. How does a pressure gradient affect a boundary layer growth?
73. What is displacement thickness?
74. What is momentum thickness?
75. Compute the Reynolds number for a given condition
76. At Re=10k and Cl=0, does an NACA 0012 or a flat plate have more drag?
77. Identify a laminar separation bubble from streamlines and Cp.
78. What is the effect of lowering Re on the drag of a flat plate airfoil?
79. What is the BL thickness and friction coefficient for a turbulent plate?
80. Discuss turbulent vs laminar separation for a sharp corner (or golf ball).
81. Estimate drag of a flat plate.

82. Estimate the drag of a complete aircraft. Component drag data would be provided.
83. Determine drag equation of an aircraft given drag data. Lesson 23 page 18.
84. How can a compressible flow be identified?
85. How does the velocity divergence scale with Mach number? $\nabla \cdot V = \sigma = M^2 \frac{dV}{ds}$
86. Where is velocity divergence positive and negative in a compressible flow?
87. Discuss streamtube thinning and thickening in the presence of a velocity divergence.
88. Compressible flows tend to magnify perturbations and the distance of action.
89. Correct a subsonic pressure coefficient to a M=0 Cp with Prandtl-Glauert.
90. Correct a M=0 lift coefficient to a high subsonic lift coefficient. Estimate Cla at M=0.5.
91. Distinguish incompressible and compressible streamlines from an image.
92. Estimate CLa for a wing at a non-zero Mach number.
93. Does induced drag increase as Mach number increases? Does profile drag increase?
94. How does momentum thickness in a BL change in the presence of a pressure gradient? Estimate θ given a known Cf and dp/ds.
95. Discuss the difference between a 2D and an axisymmetrical 3D BL. Why?
96. Estimate CLmax given Cp
97. Identify leading and trailing edge stall from Cl vs alpha. Why?
98. Identify airfoils for high lift applications.
99. Discuss how sweep affects wing performance as Mach increases
100. Given a bird wing geometry, discuss the bird's flight behavior.

Good luck! I will be available in my office (or email) for questions.

The final is on the 9th beginning at 8am.