AEM 368: Practice Exam 2 Name:___________________________

~~26~~ 29 Mar 2017 60 minutes ~~6 Pages~~ Open book, Open notes, Calculator

100 total points **Read, think, plan, and then write.**

Exam #2 covers chapters 1-2 in the Nelson FSAC book and the lecture notes from Lesson 14-20.

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:_______________________________________

AEM 368: Practice Exam 2 Name:______________________________

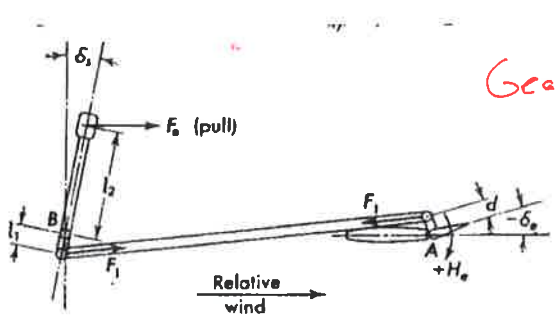
1. What is static stability? How is this contrasted with balance and trim? Is static stability sufficient for dynamic stability? (No, recall that we have not yet "connected" the pitch-yaw-roll axes together in time.)
2. What two conditions are necessary for a statically stable aircraft in the pitch axis?
3. What formal aircraft terminology is given to the condition when $C_m = 0$
4. When can an aircraft have multiple trim points?
5. Define the following term

$$C_{m_{cg_w}}$$

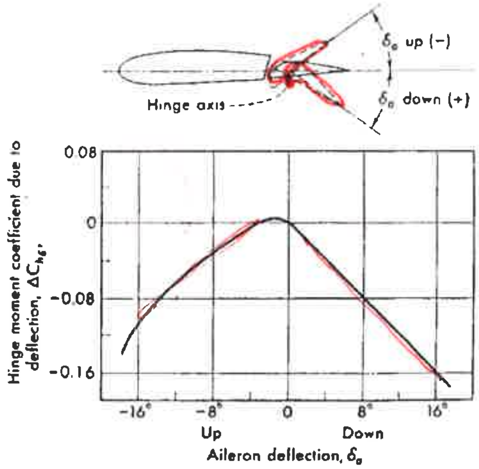
6. What assumptions were used to derive the wing contribution to pitching moment equation?

$$C_{m_{cg_w}} = C_{m_{ac_w}} + C_{L_w}\left(\frac{x_{cg}}{\bar{c}} - \frac{x_{ac}}{\bar{c}}\right)$$

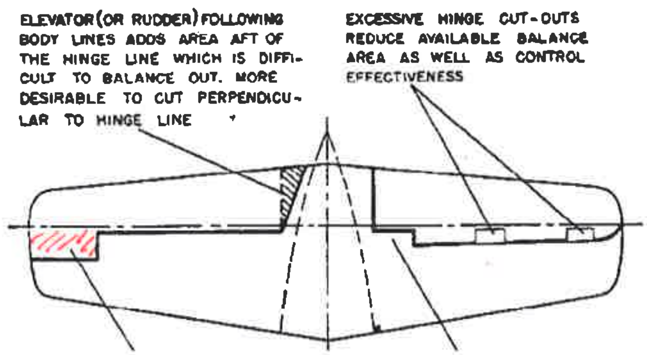
7. Why is C_{m_α} critical to static stability? Sign?
8. How does moving the CG forward change C_{m_α} and C_{m_0} ?
9. What CG and airfoil geometry properties are necessary for a flying wing?
10. What CG and airfoil geometry properties are necessary for conventional aircraft (wing + aft tail)?
11. How does an aft tail affect pitch stability? Compute.
12. How does downwash affect the stability properties of an aft tail? Canard?
13. Calculate the downwash derivative $d\epsilon / d\alpha$ for a particular configuration. Lesson15-slide8.
14. In which ways can a tail provide pitch trim?
15. What is the NP? Compute the NP for a given aircraft.
16. Given data of Cm versus alpha for various elevator angles, compute the NP, control power and trim angle.
17. For a C172 with an aft tail in the propeller wake, how does static stability depend on thrust?
18. Contrast pitch stability for a given geometry with forward and after mounted propellers.
19. What is the static margin? For an aircraft of $\bar{c} = 5$ feet, the CG is located 2 feet ahead of the NP, what is the static margin. Is this an acceptable value (i.e. Will the pilot be grumpy about having a severely nose heavy aircraft?)
20. Size the horizontal tail for an aircraft. Lesson 15 slide 11.
21. Using Multhopp's method, estimate the fuselage contribution to pitching moment. Or, using the concept of Multhopp, identify the aircraft with a particular Cm contribution.
22. Define reversible and irreversible flight control systems.
23. What is the minimal set of controls necessary for pitch and bank angle specification?
24. Given a FCS, determine the stick force at a given dynamic pressure and control deflection (with a resulting Ch)



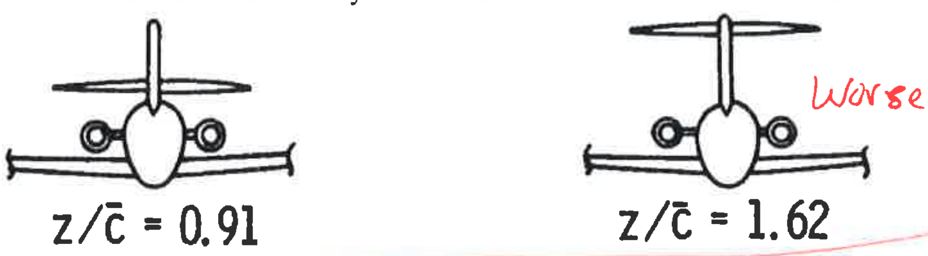
25. Why would a Frise hinge line be a particularly terrible choice for the elevator? See figure below.



26. Calculate the elevator control power for a given tail. Lesson 16 slide 9
27. Estimate the NP given flight test data (elevator vs CL vs CG)
28. How is stability affected by stick fixed and stick free conditions? Which is less stable?
29. Why is aerodynamic balance often used on aircraft control surfaces?



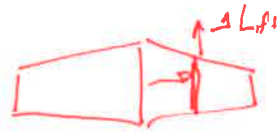
30. Which aircraft is likely to have more of an issue with deep stall?



31. Why are stick force gradients and stick-speed gradients important? Which are stable?
32. Given an aircraft with an unacceptable stick force gradient, what are strategies for improvement? Why would a downspring help? Would a bob-weight help? Why is increasing the SM not a robust method?
33. How does stick force per g vary with flight and geometry parameters?
34. How can a bob weight assist with stick force per g? Does this require an irreversible FCS?
35. Is stalling the tail possible? What would be the aircraft's reaction?
36. Why would you expect the horizontal tail to be thinner with more sweep than the main wing?

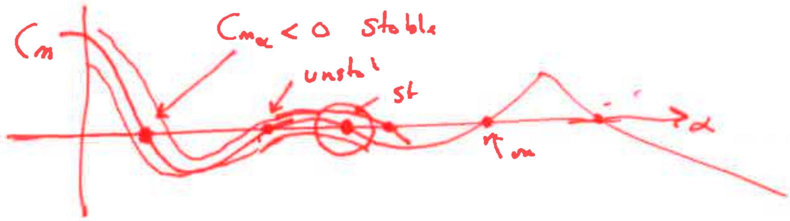
Main wing comp first

37. Name the primary contributors to directional stability and to directional trim angle.
38. Given a fuselage shape, determine the fuselage contribution to C_{n_β} (HW problem + Class; L18p7)
39. Given a geometry, determine the rudder control effectiveness. $C_{n_{\delta_r}}$
40. Discuss rudder lock. How can this occur? Find rudder float angle.
41. Discuss how dorsal fins and ventral fins can fix common problems in directional control and stability.
42. Discuss servo tabs and trim tabs. Calculate the tab angle necessary to trim an aircraft at a particular condition (when given surface and tab control derivatives)
43. Define C_L Context



44. Calculate roll damping coefficient C_{L_p} for a given wing.
45. Calculate dihedral coefficient C_{L_β} for a given wing or surface. Be prepared to do an integral.
46. How does the fuselage influence dihedral effect? Power? Why?
47. How does wing sweep affect the dihedral effect? Discuss why high wingswept high-speed aircraft with T tails often have anhedral.
48. Determine the rudder size necessary to create a specified roll moment.
49. Determine the roll control of ailerons of a particular geometry.
50. Discuss the advantages and disadvantages of ailerons, spoilers, and rudder-dihedral for roll control at various phases of flight (including high speed).

4)



9)

$C_{m_\alpha} < 0$

$C_m(C_{L_{trim}}) = 0$

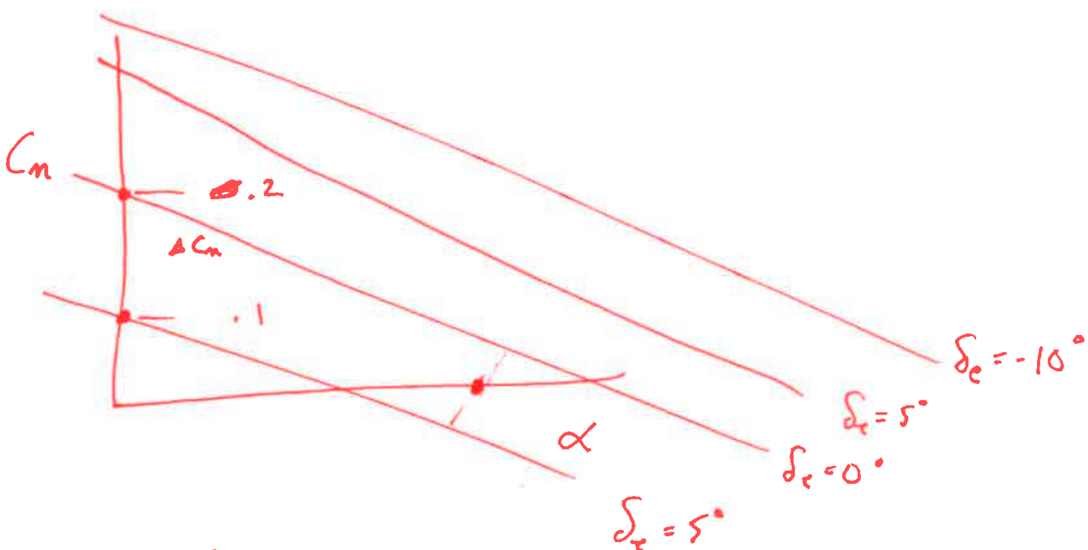
10)

$C_{m_\alpha} = -V_H C_{L_\alpha}$

19)

$SM = \frac{NP - CG}{\bar{c}} = \frac{2}{5} = 40\%$

16)



C_{m_α} ∝ C_{L_α}

$C_{m_{\delta_e}} = \frac{dC_m}{d\delta_e} = \frac{\Delta C_m}{\Delta \delta_e} = \frac{.2 - .1}{0 - 5}$

$=$