UNIVERSITY OF MICHIGAN

Department of Aeronautical Engineering

Final Examination in Ae.E. 1, Sections I and II

Room 311 W. Engineering Bldg., from 8:00 to 12:00 A.M.

Wednesday, February 12, 1941

Note: (1) This examination is given under the Honor System and the "Pledge" should be signed at the end of the examination paper.

(2) The use of notes and textbook is not allowed in this examination; slide rule only should be used in solving the numerical problems.

(3) In averaging for the final grade in this examination greater weight will be given to questions and definitions requiring more time for the answer, and still greater weight - to the solution of the problems, in proportion to the time normally involved.

(4) The estimated time necessary for writing this examination is about as follows:

The time for the 39 questions and definitions, Nos. 1 to 8, 11 to 30, 32 to 35, and 41 to 47 inclusive, at an average rate of 2 minutes per question.....	1 hr. 15 min.
The time for the solution of the 8 problems, Nos. 9, 10, 31, 36, 37, 38, 39, and 40.....	0 hr. 40 min.
TOTAL.....	1 hr. 55 min.

You have four hours in which to do this examination. Wishing you good luck, I am

Sincerely yours,

F. W. Rawlesby

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1. What is the difference between the lighter and the heavier-than-air craft, considering the methods of sustentation?
2. Who, when and where, made the first sustained controlled flights in a power-driven heavier-than-air craft, and what was the type of this flying machine?
3. Classify the lighter-than-air craft.
4. Enumerate the various types of heavier-than-air craft.
5. What is an airfoil?
6. Define the "median line," the camber-ratio and the thickness-ratio of an airfoil section.
7. Write the fundamental equation of aerodynamics using each of the three different types of coefficients (C, k and K); define all the terms used in these equations and give their dimensions.

8. What is the mass-density of air at standard conditions? State the units.

9. Given C = 1.28, calculate the corresponding value of K for standard air density and velocity in miles per hour.

10. Given K = .0013 lbs./sq.ft.:mi./hr. at standard conditions, recalculate the value of this coefficient for the temperature of 10°Fahr. and 78 cm Hg. barometric pressure.

11. What is the relation between the total air reaction and its lift and drag components? Both graphically and analytically.

12. What is the aspect ratio of a non-rectangular airfoil?

13. Give or derive the expression for A.R. of a nonrectangular airfoil.

14. Draw typical lift, drag, and L/D curves for a flat plate or a zero-camber airfoil of standard A.R. as functions of angles of attack from -90° to +90°. All three curves should be drawn on same coordinates.

15. Same as question 14, but for a typical cambered airfoil for the "important" angles of attack only.

16. Draw typical c.p. curves for a flat plate and for a cambered airfoil (standard aspect ratio) for angles of attack from -90° to +90°. Both curves on same coordinates.

17. Draw a typical polar curve and the induced drag curve for a typical airfoil. Indicate the profile drag and explain why this curve is called "polar."

18. What is the relation between C_{D_i} and C_L?

19. What is the relation between C_{D_i} and A.R.?

20. Draw a sketch showing the typical pressure distribution along the chord of an airfoil, at small positive angles of attack. Use the method explained in the class and explain the meaning of this diagram.

21. What is the effect of aspect ratio upon C_L and C_D as functions of angle of attack? State what features are subjected to changes and what are not.

22. What is the advantage of tapering the wings?

23. What is the Reynolds' Number? Define all terms used.

24. What is the purpose of the variable-density wind tunnel? Explain the conditions and principles involved.

25. Define the coefficient of moment by writing the moment equation for an airfoil (about its leading edge).

26. What are the three items into which, in general, the drag can be divided?

27. Draw sketches showing the relative position of wing sections in a "straight" biplane and in a triplane with positive stagger. Give dimensions determining the amount of stagger by both methods.

28. What is the effect of gap-chord ratio upon C_L and C_D?

29. What is the effect of stagger upon C_L and C_D?

30. What are the usual amounts of stagger and what are the reasons for them?

31. Given the parasite drag D_p = 250 lbs. at V = 140 m.p.h. at standard air conditions, calculate the equivalent flat-plate area.

32. What is the "generalized" efficiency curve of propeller?

33. Draw a sketch showing the equilibrium of forces in climbing flight. Use the direct method.

34. Same as Question 33, by means of the vector polygon.

35. Draw a sketch showing the equilibrium of forces in gliding flight, by the method of direct equality of the equal and opposite forces (as in Question 33).

36. Given an airplane having a landing speed of 65 mi./hr. near sea level, what will be its landing speed somewhere in Colorado when the density of air is 75% of that at sea level?

37. Calculate the speed and the power required to fly level an airplane, from the following data: W = 9000 lbs.; S = 500 sq. ft.; C_L = .264; C_D = .0122; a = 13.5 sq. ft., and sigma = .629.

38. Prove that at the same angle of attack the drag of an airplane is independent of the altitude at which it is flown.

39. Calculate the wing area of an airplane from the following data: W = 10,000 lbs., max. C_L = 1.6, and the stalling speed 60 mi./hr.

40. Calculate for the above airplane the speed and the power required to fly it at an altitude of 15,000 ft. (sigma = .629) assuming the equivalent flat plate area a = 12.5 sq. ft. and an angle of attack at which the wing has C_L = .264 and C_D = .0122.

41. What is the difference between static and dynamic stability?

42. What makes the airplane inherently statically longitudinally stable?

43. What makes the airplane inherently statically laterally stable?

44. What makes the airplane inherently statically directionally stable?

45. Draw a sketch showing the relative position of elevator and control stick for high speed flight.

46. Draw a sketch showing the position of ailerons and the control stick for banking, and indicate the direction of banking.

47. Draw a sketch showing the position of rudder and the rudder bar for a right-hand turn.

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