AERONAUTICS: A CLASS TEXT

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EDWIN BIDWELL WILSON

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A CLASS TEXT

BY

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1920

PREFACE

FOR several years I have been giving, at the Massachusetts Institute of Technology, courses of lectures on those portions of dynamics, both rigid and fluid, which are fundamental in aeronautical engineering. The more elementary parts of these courses, covering about ninety out of one hundred fifty lectures, are found in this book. Although it has been customary to teach the two subjects of rigid and of fluid dynamics in parallel or in rapid alternation, so that they are both developed as needed for each other and for the accompanying courses on airplane and airship design, it has seemed better in making a presentation in book form to separate them. The student should have completed Chaps. IX–XII of the fluid mechanics before undertaking the latter part of Chap. VI.

A number of topics which might well be included in a work on aeronautics have been omitted from the book, as they are from my lectures, because they can be taken up so much better in the parallel courses on design. In the preparation of the selected material I have had constantly in mind my own experience and needs relative to effective classroom instruction, particularly in the matter of lists of exercises. Although my students are supposed to have completed thorough courses in calculus, including the elements of differential equations, and in theoretical and applied mechanics, it has seemed better to assume too little, rather than too much, as retained in usable form. I hope, therefore, that with the present interest in aeronautics in particular, and in applied mathematics in general, this work may prove stimulating to other than technical students of aeronautical engineering.

Nobody can issue a book on aeronautics at this time without lamenting the fact that much, if not most, of the progress in theory which has been made during the war, particularly in England, has not yet been released for publication. To wait, however, until its release and subsequent digestion would mean a long delay. Indeed from one viewpoint no time is more appropriate for the printing of these elementary, introductory, and orienting lectures than just now when there impends a deluge of material for advanced study.

I desire to express my appreciation of the way Professor C. H. Peabody, in charge of the work in Aeronautical Engineering, has in every way encouraged and supported me. I am under the deepest personal and technical indebtedness to Dr. J. C. Hunsaker, U.S.N., with whom I was in close collaboration for three years, and upon whose published work I have had permission freely to draw for parts of Chap. VI and for most of Chap. VIII. Could I have consulted with him these last few years as I did earlier, this book would have been much improved.

EDWIN BIDWELL WILSON

July, 1919

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INTRODUCTION

RIGID MECHANICS

FLUID MECHANICS

ERRATA — AERONAUTICS

(By E. B. Wilson)

Page 10, exereise17, read radian in place of radius

" 11, line 18. $P = .0025\,\rho S U^2$ should read $P = .0025\,SU^2$

" 25, 4th line from bottom. $(SS' = \text{const.})$ should read $(S/S' = \text{const.})$

" 26, 8th line from bottom. $165{,}000/U$ should read $16{,}500/U$

" 27, Fig. 8. j and θ added. Rest same as before

" 30, equation 6 lines below equation 20. $W^2 : kk'SS'R^2g^2$ should read $W^2 : kk'SS'R^2g^6$

Two lines below this equation. $(115/R^2)$ should read $(415/R)^2$

Two lines below. 280 ft. should read 208 ft.

" 31, Fig. 10. Angle i' should be j and i' is larger angle

" 32, equation (22).

$i' = -cj(i+j)\dfrac{bS}{S'}\dfrac{k}{k'}$ should read $i' = -cj(i+j)\dfrac{bS}{l\,S'}\dfrac{k}{k'}$

" 34, line 16. $a\,dSU^2(i+j)$ should read $a\,kSU^2(i+j)$

Two lines below. $lk'S'U^2(i'+j)$ should read $k'S'U^2(i'+j)$

Next line. $lk'S'U^2(i'+j+dj)$ should read $k'S'U^2(i'+j+dj)$

Two lines below. $U^2\,dj\,kSe - cbkS(i+j) - lk'S' \times 1$ should read $U^2\,dj[kSa - cbkS(i+j) - k'S' \times 1]$

" 40, second equation on page.

$X = \dfrac{W}{2\,kg}\log_e\dfrac{F + kr_0}{F + kw^2}$ etc. should read $X = \dfrac{W}{2\,kg}\log_e\dfrac{F + ke_0^2}{F + kw^2}$ etc.

" 41, line 4. *Movements* should read *moments*

" 43, equation (9). $\left(I - \dfrac{r_0^2}{i^2}\right)$ should read $\left(1 - \dfrac{r_0^2}{i^2}\right)$

" 50, third line below Fig. 12. $-2\rho dS$ should read $=2\rho S$

" 51, line 2. Wing should read wind.

" 52, equation (27). $R = \dfrac{kV^2}{2g}W$ should read $R = kV^2W$

" 53, line two, read e^{U^2} in place of $2\,g\kappa/U^2$

" line 7. $v_0 = 0$, $dy/du = 0$ should read $v_0 = 0$, $dy/dx = 0$

Three lines below equation (32). Approximately for y should read approximately for x

" 55, Prob. 4. Altitude should read attitude.

Prob. 6, second line. Require should read acquire.

" 57, last word in first paragraph. Airplan should read airplane.

" 62, equation (22). $\sqrt{\dfrac{gE}{l}}$ should read $\sqrt{\dfrac{1}{Eg}}$

" 63, equation (25). $\sqrt{\dfrac{cgW}{l}}$ should read $\sqrt{\dfrac{l}{cgW}}$

" 64, equation (28) should read $T = 2\pi\sqrt{\dfrac{l}{cgW}}$ or $l = \dfrac{cgWT^2}{4\pi^2}$

Equation (30) should read $l_0 = \left(\dfrac{cgT^2}{4\pi^2} - U^2\right)W$

Equation (31) should read $T = 2\pi\sqrt{\dfrac{l}{Eg}}$ or $l = \dfrac{EgT^2}{4\pi^2}$

Page 65, Equation (32) should read $I_1 = \frac{EgT_1^2}{4\pi^2}$ then $E = \frac{4\pi^2 I_1}{gT_1^2}$

Equation (33) should read $I = \frac{I_1 T^2}{T_1^2}$

" 69, in equation (41) all exponents should be negative
In (44) the number $\frac{1}{2}$ should be 2

" 74, equation above equation (61).

$ue^{-2gkx/W} = \frac{EW}{2gk^2}\left(\frac{2gk}{E}\right.$ should read $ue^{-2gkx/W} = \frac{EW}{2gk^2}\left(\frac{2gk}{W}\right.$

" 76, equation (70).

$B = \frac{(b-n^2)}{(b-n^2)^2+a^2n^2}$ should read $B = \frac{c(b-n^2)}{(b-n^2)^2+a^2n^2}$

" 77, equation (74). $\cos = \frac{(b-n^2)c}{(b-n^2)^2+a^2n^2}$, $\sin = \frac{anc}{(b^2-n^2)^2+a^2n^2}$

should read $\cos\Gamma = \frac{(b-n^2)}{\sqrt{(b-n^2)^2+a^2n^2}}$, $\sin\Gamma = \frac{an}{\sqrt{(b-n^2)^2+a^2n^2}}$

Equation (77). $\frac{c}{a\sqrt{b-a^2/4}}$ should read $\frac{c}{a\sqrt{b-a^2/4}}$

Equation (78), latter part. $\tan^{-1}2\sqrt{b/a}$ should read $\tan^{-1}2\frac{\sqrt{b}}{a}$

" 79, Exercise 15, second sentence. 1/10 = amplitude should read 1/10 amplitude

" 80, Number of page should be on left-hand side of page.

" 88, in (23), first line, read $\frac{\partial X}{\partial q}q$ instead of $\frac{\partial x}{\partial q}q$

" 90, 4 lines from bottom of page. $Z - dZ =$ etc. should read $Z + dZ =$ etc.

" 91, equation (29) $dZ = \frac{57.3}{U}\frac{dL}{D} +$ etc. should read $dZ = \frac{57.3}{U}\frac{dL}{di} +$ etc.

" 93, beginning of second paragraph. A rough calculation $\partial M/\partial q$ etc, should read A rough calculation for $\partial M/\partial q$ etc.

Line 5 in the same paragraph, next to the last word in the line should read wind instead of wing.

The following equation which reads

$P = k\frac{W}{l}SU^2$ should read $P = k\frac{w}{l}SU^2$

" 96. The line above equation (42) which reads equation (42) and the expression, should read equation (41) and the expression

" 100, line 12, which reads, The model was 1.24 size and turned should read The model was 1/24 size and tunnel

" 104, equation 49. The third part, which reads

$\frac{\partial X}{\partial\theta} = U\frac{\partial X}{\partial w} - W$, should read $\frac{\partial X}{\partial\theta} = U\frac{\partial X}{\partial w} + W$

Three lines below equation 49, which reads, If the middle row etc., should read If the middle column etc.

" 106, Exercise 22. Line 3, which reads model 16 sec. when $i = 10$. should read model 16 sec. when $i = 1°$

" 109, Equation following equation (11), which reads

$dh_1 = (y^2+z^2)p - zyq - xzr\,dW$ should read

$dh_1 = [(y^2+z^2)p - xyq - xzr]\,dW$

" 115, equation (32). *Second part*, which reads

$W\frac{\delta a}{dt} = W$ etc. should read $W\frac{\delta v}{dt} = W$ etc.