

Contents

Preface	ix
1 History of Aviation	1
1.1 Introduction	1
1.2 Early history and the invention of ballooning	3
1.3 The period between 1799 and 1870	8
1.4 The decades between 1870 and 1890	12
1.5 From 1890 until the Wright Flyer III	15
1.6 European aviation between 1906 and 1918	22
1.7 Aviation between the world wars	29
1.8 Development after 1940	37
Bibliography	45
2 Introduction to Atmospheric Flight	47
2.1 Flying – How is that possible?	47
2.2 Static and dynamic aviation	49
2.3 Forces on the aeroplane	55
2.4 Lift, drag and thrust	58
2.5 Properties of air	62
2.6 The earth's atmosphere	67
2.7 The standard atmosphere	69
2.8 Atmospheric flight	78
Bibliography	84
3 Low-Speed Aerodynamics	87
3.1 Speed domains and compressibility	88
3.2 Basic concepts	89
3.3 Equations for steady flow	93
3.4 Viscous flows	102

3.5	The boundary layer	105
3.6	Flow separation and drag	109
3.7	Shape and scale effects on drag	116
	Bibliography	123
4	Lift and Drag at Low Speeds	125
4.1	Function and shape of aeroplane wings	125
4.2	Aerofoil sections	128
4.3	Circulation and lift	137
4.4	Aerofoil section properties	145
4.5	Wing geometry	153
4.6	High-aspect ratio straight wings	158
4.7	Low-aspect ratio wings	169
4.8	The whole aircraft	172
	Bibliography	178
5	Aircraft Engines and Propulsion	181
5.1	History of engine development	181
5.2	Fundamentals of reaction propulsion	196
5.3	Engine efficiency and fuel consumption	205
5.4	Piston engines in aviation	209
5.5	Gas turbine engine components	215
5.6	Non-reheated turbojet and turbofan engines	221
5.7	Turboprop and turboshaft engines	227
5.8	Gas turbine engine operation	231
5.9	Propeller performance	236
	Bibliography	251
6	Aeroplane Performance	253
6.1	Introduction	253
6.2	Airspeed and altitude	258
6.3	Equations of motion for symmetric flight	260
6.4	Steady straight and level flight	265
6.5	Climb and descent	279
6.6	Gliding flight	288
6.7	Cruising flight	292
6.8	Take-off and landing	302
6.9	Horizontal steady turn	314
6.10	Manoeuvre and gust loads	319
	Bibliography	324

7	Stability and Control	327
7.1	Flying qualities	328
7.2	Elementary concepts and definitions	333
7.3	Tail surfaces and flight control	342
7.4	Pitching moment of aerofoils	349
7.5	Static longitudinal stability	358
7.6	Dynamic longitudinal stability	368
7.7	Longitudinal control	371
7.8	Static lateral stability	384
7.9	Dynamic lateral stability	388
7.10	Lateral control	391
7.11	Stalling and spinning	395
	Bibliography	401
8	Helicopter Flight Mechanics	405
8.1	Helicopter general arrangements	406
8.2	Hovering flight	408
8.3	The rotor in level flight	413
8.4	Flight performance	417
8.5	Stability and control	422
	Bibliography	429
9	High-Speed Flight	431
9.1	Complications due to the compressibility of air	431
9.2	Compressible flow relationships	436
9.3	Speed of sound and Mach number	441
9.4	Flow in a channel	446
9.5	Shock waves and expansion flows	450
9.6	High-subsonic speed	460
9.7	Transonic speed	468
9.8	Supersonic speed	476
9.9	Supersonic propulsion	488
9.10	Performance and operation	496
	Bibliography	509
A	Units and Dimensions	511
B	Principles of Aerostatics	517
	Index	523