

# Contents

---

<i>Preface</i>	<i>page ix</i>
<b>1 Scope of the book</b>	<b>1</b>
<b>2 Steady flows bounded by plane boundaries</b>	<b>11</b>
2.1 Plane Couette–Poiseuille flow	11
2.2 Beltrami flows and their generalisation	15
2.2.1 Flow downstream of a grid	17
2.2.2 Flow due to a stretching plate	17
2.2.3 Flow into a corner	19
2.2.4 The asymptotic suction profile	19
2.3 Stagnation-point flows	20
2.3.1 The classical Hiemenz (1911) solution	20
2.3.2 Oblique stagnation-point flows	23
2.3.3 Two-fluid stagnation-point flow	26
2.4 Channel flows	28
2.4.1 Parallel-sided channels	28
2.4.2 Non-parallel-sided channels	32
2.5 Three-dimensional flows	38
2.5.1 A corner flow	38
2.5.2 A swept stagnation flow	39
2.5.3 Vortices in a stagnation flow	40
2.5.4 Three-dimensional stagnation-point flow	42
<b>3 Steady axisymmetric and related flows</b>	<b>45</b>
3.1 Circular pipe flow	45
3.2 Non-circular pipe flow	50
3.3 Beltrami flows and their generalisation	50

3.4	Stagnation-point flows	53
3.4.1	The classical Homann (1936) solution	53
3.4.2	Stagnation on a circular cylinder	56
3.4.3	Flow inside a porous or stretching tube	62
3.5	Rotating-disk flows	68
3.5.1	The one-disk problem	69
3.5.2	The two-disk problem	73
3.6	Ekman flow	77
3.7	Concentrated flows: jets and vortices	78
3.7.1	The round jet	78
3.7.2	The Burgers vortex	82
3.7.3	The influence of boundaries	83
<b>4</b>	<b>Unsteady flows bounded by plane boundaries</b>	<b>89</b>
4.1	The oscillating plate	90
4.2	Impulsive flows	91
4.2.1	Applied body force	93
4.2.2	Applied shear stress	94
4.2.3	Diffusion of a vortex sheet	95
4.3	More general flows	96
4.4	The angled flat plate	98
4.5	Unsteady plate stretching	100
4.6	Beltrami flows and their generalisation	101
4.7	Stagnation-point flows	106
4.7.1	Transverse oscillations	106
4.7.2	Orthogonal oscillations	109
4.7.3	Superposed shear flows	113
4.7.4	Three-dimensional stagnation-point flow	114
4.7.5	Rotational three-dimensional stagnation-point flow	116
4.7.6	Flow at a rear stagnation point	118
4.8	Channel flows	119
4.8.1	Fixed boundaries	119
4.8.2	Squeeze flows	121
4.8.3	Periodic solutions	124
<b>5</b>	<b>Unsteady axisymmetric and related flows</b>	<b>128</b>
5.1	Pipe and cylinder flows	128
5.1.1	Impulsive pipe flow	128
5.1.2	Periodic pipe flow	129

5.1.3	Pulsed pipe flow	130
5.1.4	The effects of suction or injection on periodic flow	132
5.1.5	Pipes with varying radius	136
5.1.6	Impulsive cylinder flows	138
5.2	Beltrami flows and their generalisation	142
5.3	Stagnation-point flows	142
5.3.1	The Homann flow against an oscillating plate	143
5.3.2	Oblique stagnation-point flow	146
5.3.3	Unsteady stagnation on a circular cylinder	148
5.4	Squeeze flows	151
5.4.1	Constant force	152
5.4.2	Prescribed gap width	154
5.5	Rotating-disk flows	156
5.5.1	Self-similar flows	156
5.5.2	Rotating disk in a counter-rotating fluid	161
5.5.3	Non-axisymmetric flows	164
5.5.4	An Ekman flow	167
5.6	Vortex motion	169
5.6.1	Single-cell vortices	169
5.6.2	Multi-cell vortices	172
5.6.3	The influence of boundaries	177
	<i>References</i>	181
	<i>Index</i>	195

