CONTENTS

Preface xi

1 Introduction to Magnetohydrodynamics 1
- 1 Fluid Model for a Plasma 1
- 2 Dynamics of a Perfectly Conducting Fluid 2
- 3 Magnetohydrostatics 10
- 4 Magnetohydrodynamic Waves 18
- 5 Anisotropic Plasma 25
- 6 The Problem of Hydromagnetic Stability 28

2 Thermal Instability of a Layer of Fluid Heated from Below 34
- 1 Nornal-Mode Analysis 35
- 2 Variational Principle 39

3 Stability of a Couette Flow 43
- 1 Governing Equations and the Steady State 43
- 2 Inviscid Couette Flow with Axial Magnetic Field 45
- 3 Inviscid Couette Flow with Axial Current 48
- 4 Viscous Couette Flow with Axial Magnetic Field 50
- 5 Stability of a Rotating Gas 53
- 6 Generalised Non-Dissipative Couette Flow 56

4 Rayleigh–Taylor Instability 66
- 1 Effect of a Vertical Magnetic Field on Rayleigh–Taylor Instability 67
- 2 Effect of a Horizontal Magnetic Field on Rayleigh–Taylor Instability 71
- 3 Rayleigh–Taylor Instability of a Compressible Plasma in a Vertical Magnetic Field 74
- 4 Rayleigh–Taylor Instability of a Compressible Plasma in Horizontal Magnetic Field 79

5 Kelvin–Helmholtz Instability 88
1 Effect of an Aligned Magnetic Field on the Kelvin–Helmholtz Instability 88
2 Effect of a Transverse Magnetic Field on the Kelvin–Helmholtz Instability 92
3 Kelvin–Helmholtz Instability of a Compressible Plasma in a Magnetic Field 93
4 Stability of the Interface Between a Gas Stream and a Liquid 101

6 A Generalised Theory of Stability of Superposed Fluids 109
1 The Governing Equations 109
2 The Boundary Condition 111
3 The Dispersion Relation 113
4 Rayleigh–Taylor Instability 115
5 Kelvin–Helmholtz Instability 116

7 Stability of Parallel Shear Flows 117
1 Parallel Incompressible Flows 117
2 Parallel Compressible Flows 124

8 Capillary Instability of Flow in a Jet 135

9 Stability of the Pinch 146
1 Case with Current Concentrated at the Surface 148
2 Case with Uniformly Distributed Current 153

10 Energy Principle for Hydromagnetic Stability 158

11 Parametric Instabilities 179
1 An Elementary Prototype of Parametric Instability 179
2 Parametric Amplification of Alfvén Waves 182
3 Parametric Stabilization of Fire-hose Instability 188
4 Parametric Stabilization of Rayleigh–Taylor Instability 191

12 Finite-resistivity Effects 197
1 Rayleigh–Taylor Instability 197

2 Kelvin–Helmholtz Instability 203
3 Tearing-Mode Instabilities 208

13 Instabilities in a Self-Gravitating Fluid 236
1 Gravitational Instability of an Infinite Homogeneous Medium 236
2 Instability of a Self-Gravitating Streaming Layer 243
3 Instability of an Infinite Cylinder of Self-Gravitating Compressible Fluid 249

14 Nonlinear Effects 257
1 The Rayleigh–Taylor Instability of a Plasma in a Magnetic Field 259

References 267

Index 271