

Contents

Introduction	v
1 Basic concepts and mathematical methods	1
1.1 Evolution equations. Dynamical systems	1
1.2 Ill-posed problems	3
1.3 Liapunov stability	5
1.4 Topology dependent stability	7
1.5 Normal modes analysis	10
1.6 Fundamental topics of nonlinear stability	12
1.7 Liapunov direct method	20
1.8 The norm as Liapunov function: the energy method	23
2 Equations of Fluid Mechanics	27
2.1 Equations of balance of continuum mechanics	27
2.2 Constitutive assumptions for fluid behavior	29
2.3 Governing equations of fluid dynamics	35
2.4 Oberbeck-Boussinesq approximation	36
2.5 Equations of magnetohydrodynamics	43
2.6 Porous media	46
2.7 Porosity, seepage velocity and the equation of continuity . . .	47
2.8 Linear momentum equation in a porous medium	48
2.8.1 Darcy's law	48
2.8.2 Brinkman's equations	50
2.9 Energy equation in a porous medium	51
3 Laminar flows in fluids with tempearture and pressure de- pendent viscosity	53
3.1 Introduction	53
3.2 Laminar flows	54
3.3 Laminar flows in polymer melts	56

3.4	Couette and Poiseuille flows of bitumen	61
4	Stability analysis of the Rayleigh-Bénard convection for a fluid with temperature and pressure dependent viscosity	65
4.1	Introduction	65
4.2	The problem	67
4.3	Linear stability analysis	70
4.4	Nonlinear stability	75
4.5	Numerical results	82
5	Stability of MHD laminar flows in a porous medium with Brinkman law	85
5.1	Mathematical formulation of the problem	85
5.2	Laminar MHD flows	87
5.2.1	Hartmann flow	88
5.2.2	Couette flow	89
5.3	Sufficient condition for linear stability	90
5.4	Sufficient condition for global non linear exponential stability	95
5.4.1	Non linear stability of the MHD laminar flows with respect to disturbances normal to the embedding magnetic field	98
5.5	The convergence of the Galerkin method	98
A	Matrix Green function	105