CONTENTS

Introduction	**vii**
Chapter I. Kirchhoff's laws	**1**
0. Examples of infinite electrical networks	1
1. Graphs and networks	3
2. Chains and cochains	8
3. Kirchhoff's equations	12
4. The associated Markov chain	14
5. Harmonic functions	18
Chapter II. Finite networks	**22**
1. Existence and uniqueness of currents	22
2. The effective resistance	25
3. Three basic principles	28
Chapter III. Currents and potentials with finite energy	**32**
1. Finite energy and Dirichlet sums	32
2. Existence of currents with finite energy	36
3. The minimal current	39
4. Transient networks	43
5. Recurrent networks	46
6. Dirichlet's and Rayleigh's principles	51
7. Decomposition and approximation of functions in **D**	58
8. Extremal length	63
9. Limits of Dirichlet functions along paths	67
Chapter IV. Uniqueness and related topics	**72**
1. Spaces of cycles	72
2. Bounded automorphisms	74
3. Cartesian products	77
4. Nonuniqueness and ends	79
5. The strong isoperimetric inequality	81
6. Graphs embedded in the hyperbolic disk	89
7. Nonuniqueness and hyperbolic graphs	93
8. Moderate growth and Foster's averaging formula	96
Chapter V. Some examples and computations	**100**
1. Transience of infinite grids	100
2. Potentials in $\mathbb{Z}^n$	104
3. Ungrounded cascades	109
4. Grounded cascades. Generalized networks	113

5. The strong isoperimetric inequality for trees 119
6. Capacity of the boundary of a tree 121
7. Edge graphs of tilings of the plane 125

Chapter VI. Royden's compactification **131**
1. The algebra **BD** 131
2. Properties of Royden's compactification 134
3. Boundary points 139
4. The harmonic measure 146
5. Spaces **HD** of finite dimension 151
6. Compactification of subnetworks 154

Chapter VII. Rough isometries **160**
1. Rough isometries in metric spaces 160
2. Some lemmas 161
3. Recurrence, class O_{HD} and rough isometries 166
4. Combinatorial boundaries 170

Appendix. Nonlinear networks **173**
1. Nonlinear networks and modular sequence spaces 173
2. p–networks 176

Bibliography **179**

Index **184**