

TABLE OF CONTENTS

| | |
|--|----|
| 1. <u>The general form of a neural network</u> | 1 |
| 1.1 Introduction | 1 |
| 1.2 The transformation of impulse frequencies into generator potentials (intercellular transmission) | 1 |
| 1.3 The transformation of generator potentials into impulse frequencies (intracellular transmission) | 7 |
| 1.4 Structures of neural networks | 11 |
| 2. <u>On the relations between several models for neural networks</u> | 14 |
| 2.1 The retinal network of <u>Limulus polyphemus</u> ; the Hartline-Ratliff equations | 15 |
| 2.2 A statistical approach: activities in coupled neuron pools; models of Cowan, Feldman, Wilson | 16 |
| 2.3 Discrete models | 19 |
| a) the logical neurons of McCulloch and Pitts | |
| b) discrete time and continuous states | 20 |
| 3. <u>Existence and uniqueness of time dependent solutions</u> | 21 |
| 4. <u>Steady states of finite-dimensional networks</u> | 26 |
| 4.1 Existence problem | 26 |
| 4.2 The number of steady states | 29 |
| a) single neurons | 29 |
| b) pairs of neurons | 33 |
| c) arbitrarily many neurons | 36 |
| 4.3 Input-output behavior of stationary networks | 45 |
| 4.4 An example of spatial hysteresis | 48 |
| 5. <u>Local stability analysis of nets with finitely many neurons</u> | 50 |
| 5.1 Introduction | 50 |
| 5.2 The linearization principle | 51 |
| 5.3 Some simple general criteria for asymptotic stability | 59 |
| 5.4 Single neurons | 62 |
| 5.5 Pairs of neurons | 70 |
| 5.6 Closed chains of neurons | 77 |

| | |
|---|-----|
| 6. <u>Oscillations in nets with finitely many neurons</u> | 81 |
| 6.1 Introduction | 81 |
| 6.2 Oscillations in closed chains of neurons | 81 |
| 6.3 Oscillations in systems with delays | 91 |
| 7. <u>Homogeneous tissues with lateral excitation or lateral inhibition</u> | 105 |
| 7.1 Introduction | 105 |
| 7.2 The model | 106 |
| 7.3 Stationary solutions and their stability | 109 |
| 7.4 Thresholds in bistable tissues | 113 |
| 7.5 Traveling fronts | 116 |
| 7.6 Diverging pairs of fronts (spread of excitation or depression) | 119 |
| 8. <u>Homogeneous tissues with lateral excitation and self-inhibition</u> | 121 |
| 8.1 The model | 121 |
| 8.2 Bulk oscillations | 124 |
| 8.3 Traveling pulses (solitary waves) | 127 |
| 8.4 Traveling wave trains | 132 |
| 9. <u>Homogeneous tissues with lateral inhibition and self- or local excitation</u> | 135 |
| 9.1 The model | 135 |
| 9.2 Periodic spatial patterns | 137 |
| 9.3 Stability | 141 |
| 9.4 Miscellaneous topics | 144 |
| References | 145 |
| List of symbols | 158 |
| Index | 159 |