

## TABLE OF CONTENTS

1. Introduction .....	5
2. Least-Squares Estimates – Basic Properties .....	8
2.1. Least-Squares Estimates are Conditional Expectations .....	8
2.2. Linear Least-Squares Estimates .....	15
2.3. Geometric Interpretations and Orthogonality Conditions .....	22
2.4. Multivariate Problems .....	30
2.5. Smoothing for Stationary Processes .....	31
3. Wiener Filters .....	38
3.1. The Wiener-Hopf Equation .....	38
3.2. Lumped Processes .....	40
3.3. The Wiener-Hopf Technique .....	45
3.4. The Innovations Approach .....	50
3.5. State-Space Approach to Wiener Filters .....	56
4. Generalizations of Wiener Filtering .....	71
5. Discrete-Time Recursive Estimation and the Kalman Filter .....	81
6. Continuous-Time Kalman Filters .....	94
6.1. Discrete-Time Approximations .....	94
6.2. Application to the Filtering Problem .....	96
6.3. Relation to Deterministic Observers .....	101
6.4. The Innovations Process in Continuous-Time .....	103
6.5. Innovations Derivation of the Continuous-Time Kalman Filter ..	107
7. Relations to Wiener Filters .....	114
7.1. State-Space Models for Stationary Processes .....	114
7.2. Steady State Kalman Filter for Stationary Processes .....	116
7.3. Spectral Factorization and the Steady-State Riccati Equation ..	118
8. Recursive Wiener Filters .....	123
9. Fast Algorithms for Continuous-Time Constant-Parameter Models .....	131
10. Some Further Reading .....	138
Appendix I : Some New Results and Insights in Linear Least-Squares Estimation Theory .....	147

<b>Abstract</b>	148
I. Introduction	148
II. The Path to State-Space Models and Riccati Type Equations.	150
III. Chandrasekhar-Type Equations and the Path Back to Input-Output Models	154
IV. Recursions for the Impulse Response of the Optimal Filter	158
V. Specializing the Input-Output Recursions to the State-Space Case	161
VI. Concluding Remarks	165
VII. Acknowledgments	165