

# Adaptive and Robust Control One-Day Tutorial

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- 1. Introduction – 20 minutes**  
What are adaptive and robust control and why are they needed  
Examples
- 2. Introduction to adaptive control – 30 minutes**  
Types of adaptive control  
Gain scheduling, model reference control, self-tuning control  
Advantages and disadvantages of each
- 3. Self-tuning control – 140 minutes**  
Parameter estimation – 60 minutes  
Least Squares and Recursive Least Squares  
How to treat some pathological cases  
Regulator design – 80 minutes  
Pole/zero placement, minimum variance, predictive control  
Examples
- 4. Conclusions and link to robust control – 20 minutes**
- 5. Introduction to robust control – 30 minutes**  
Types of robust control  
Linear Quadratic Gaussian,  $H_\infty$   
Advantages and disadvantages of each
- 6. Linear Quadratic Gaussian with Loop Transfer Recovery – 75 minutes**  
Robustness of the linear quadratic regulator  
Loss of robustness in the LQG controller  
Recovering the robustness properties  
Example
- 7.  $H_\infty$  control – 75 minutes**  
The standard  $H_\infty$  control problem  
Formulating into a model matching problem  
Solving the design problem  
Example
- 8. Summary, Comparisons, and Conclusions – 30 minutes**

## **Schedule**

Tutorial should be scheduled for 7 hours of presentation, 1 hour for lunch, and two 30-minute breaks. The schedule could be 8:00 a.m. to 5:00 p.m., with lunch from 12:00 p.m. to 1:00 p.m. Breaks would be after Parameter Estimation (from 9:50 a.m. to 10:20 a.m.) and after Linear Quadratic Gaussian with Loop Transfer Recovery (from 2:45 p.m. to 3:15 p.m.).

## **Biographical Sketches**

**Guy Beale** received the B.S.E.E. degree from Virginia Polytechnic Institute in December 1967, the M.S. degree in physics from Lynchburg College in 1974, and the Ph.D. in electrical engineering from the University of Virginia in 1977. From 1968 to 1970 he served as a commissioned officer on active duty in the U.S. Army. Between 1971 and 1981 he was employed by The Babcock & Wilcox Company in Lynchburg, VA. There he was involved in the development and design of automated manufacturing and high-precision computer-based inspection systems. From 1981 to 1986 Dr. Beale was at Vanderbilt University as an Assistant Professor of Electrical Engineering. His research included work in digital autopilot design and diagnostic expert systems. In September 1986 he joined the faculty at George Mason University in Fairfax, Virginia where he is currently an Associate Professor of Electrical and Computer Engineering. His teaching and research interests include the application of advanced control techniques, particularly robust control. He has been actively involved in research and design of submarine maneuvering control systems for the U.S. Navy since 1987. He is a Senior Member of the IEEE, and a member of IEEE Industrial Electronics Society and Control Systems Society. He is active in IEEE and IFAC conferences that specialize in control applications.

**Zoran Vukić** is an Associate Professor of Control Engineering at the University of Zagreb, Faculty of Electrical Engineering and Computing. He received the B.S.E.E. degree from the University of Zagreb in 1972 and the M.S. and Ph.D. degrees in electrical engineering from the same university. He teaches and does research in control systems and guidance of marine vehicles. Between 1992 and 1996 he was Head of the Department of Control and Computer Engineering in Automation, University of Zagreb. His research interest is the application of control theory to marine vehicles and marine systems. His specific interests have been adaptive control, robust control, identification and nonlinear control. He is currently working in the area of intelligent and fault tolerant control. During 1984/85 academic year, he was a Fulbright fellow at Vanderbilt University, and in 1985/86 he was a visiting lecturer in the Electrical Engineering Department at Vanderbilt. Member of KoREMA, IEEE and IFAC Technical Committees on Marine Systems and on Robust Control. Member of the International Program Committees of IFAC Conferences: CAMS'92, CAMS'95, MCMC'97, CAMS'98 and CAMS'2001. General Chairman of the International Program Committee of MCMC'2000, Aalborg, Denmark and also general co-chairman of the 9<sup>th</sup> IEEE Mediterranean Conference on Control and Automation, June 27-29, 2001 Dubrovnik, Croatia.