

## Department of Electrical and Computer Engineering

**Title:** «*Optimal Control of Battery – Operated Systems*»

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**Room XΩΔ 02 - 008, New Campus**  
**University of Cyprus**

**Abstract:** Motivated by the increasing dependence of many systems on battery energy (e.g., wireless sensor networks, mobile robots, electric vehicles), we will discuss the problem of optimally controlling how to discharge and recharge a non-ideal battery so as to maximize the work it can perform over a given time period and still maintain a desired final energy level. Modeling a battery as a dynamic system, we adopt a Kinetic Battery Model (KBM) and formulate a finite-horizon optimal control problem. The solution is shown to be of bang–bang type with the property that the battery is always in recharging mode during the last part of the interval. We then extend the problem to settings where recharging is only occasionally feasible and show that it can be reduced to a nonlinear optimization problem. We further study the problem of optimally controlling a set of non-ideal rechargeable batteries that can be shared to perform a given amount of work over some specified time period. In this case, we seek to maximize the minimum residual energy among all batteries at the end of this period. We show that the optimal solution must result in equal residual energies for all batteries as long as such a policy is feasible. This simplifies the task of subsequently deriving explicit solutions for the problem.



**Biography:** **Christos G. Cassandras** is Head of the Division of Systems Engineering and Professor of Electrical and Computer Engineering at Boston University. He is also co-founder of Boston University's Center for Information and Systems Engineering (CISE). He received degrees from Yale University (B.S., 1977), Stanford University (M.S.E.E., 1978), and Harvard University (S.M., 1979; Ph.D., 1982). In 1982-84 he was with ITP Boston, Inc. where he worked on the design of automated manufacturing systems. In 1984-1996 he was a faculty member at the Department of

Electrical and Computer Engineering, University of Massachusetts/Amherst. He specializes in the areas of discrete event and hybrid systems, stochastic optimization, and computer simulation, with applications to computer and sensor networks, manufacturing systems, and transportation systems. He has published over 300 refereed papers in these areas, and five books. He has guest-edited several technical journal issues and serves on several journal Editorial Boards. He has recently collaborated with The MathWorks, Inc. in the development of the discrete event and hybrid system simulator SimEvents.

Dr. Cassandras was Editor-in-Chief of the *IEEE Transactions on Automatic Control* from 1998 through 2009 and has also served as Editor for Technical Notes and Correspondence and Associate Editor. He was the 2012 President of the IEEE Control Systems Society (CSS) and has served as Vice President for Publications and on the Board of Governors of the CSS. He has chaired the CSS Technical Committee on Control Theory, and served as Chair of several conferences. He has been a plenary speaker at many international conferences, including the *American Control Conference* in 2001 and the *IEEE Conference on Decision and Control* in 2002, and an IEEE Distinguished Lecturer.

He is the recipient of several awards, including the 2011 IEEE Control Systems Technology Award, the Distinguished Member Award of the IEEE Control Systems Society (2006), the 1999 Harold Chestnut Prize (IFAC Best Control Engineering Textbook) for *Discrete Event Systems: Modeling and Performance Analysis*, a 2011 prize for the IBM/IEEE Smarter Planet Challenge competition, a 1991 Lilly Fellowship and a 2012 Kern Fellowship. He is a member of Phi Beta Kappa and Tau Beta Pi. He is also a Fellow of the IEEE and a Fellow of the IFAC.