

## John Doyle

### Education/training

|                                       |                        |        |      |
|---------------------------------------|------------------------|--------|------|
| Massachusetts Institute of Technology | Electrical Engineering | BS &MS | 1977 |
| University of California at Berkeley  | Mathematics            | Ph.D.  | 1984 |

**Research Interests:** Mathematical foundations for complex networks in biology, neuroscience, medicine, and technology. Focus on hard limits on achievable robust performance, architectures, and protocols that achieve these limits, scalable algorithms to implement protocols and do statistical and robustness analysis of data and systems, and the nature of adaptation and evolution. Recent case study applications include cell biology, medical physiology, turbulence, theoretical foundations of statistical mechanics, network protocol design, smartgrid control and optimization, brain architecture, hybrid circuit design, wildfire ecology, and earthquake statistics.

### Employment History

|           |                                                                    |
|-----------|--------------------------------------------------------------------|
| 2014-     | Jean-Lou Chameau Professor, CDS, EE, and BioE, Caltech             |
| 2004-2014 | John G Braun Professor, CDS, EE, and BioE, Caltech                 |
| 1991-     | Professor, Control & Dynamical Systems and EE, Caltech             |
| 1986-1990 | Associate Professor (with tenure), Electrical Eng, Caltech         |
| 1976-1990 | Consultant, Honeywell Systems and Research Center, Minneapolis, MN |

### Prize/Best Papers

|      |                                                                                                                                                                                        |
|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1988 | IEEE Trans Auto Ctrl for "Robust control of ill-conditioned plants: high-purity distillation"                                                                                          |
| 1989 | IEEE Trans Auto Ctrl for "State-space solutions to standard $H_2$ and $H_\infty$ optimal control problems"                                                                             |
| 1990 | IEEE Baker Prize (all IEEE publications) for "State-space solutions..." (Also ranked in the top 10 "most important" papers world-wide in pure and applied mathematics from 1981-1993.) |
| 1994 | ACC Schuck Best Paper Award for "Behavioral Approach to Robustness Analysis"                                                                                                           |
| 2004 | ACM Sigcomm: "A First-Principles Approach to Understanding the Internet's Router-level Topology"                                                                                       |

### Individual Awards

|                                                               |                                                                    |
|---------------------------------------------------------------|--------------------------------------------------------------------|
| 1977                                                          | IEEE Power and Energy Society Hickernell Award                     |
| 1983                                                          | American Automatic Control Council (AACC) Eckman Award             |
| 1984                                                          | Bernard Friedman Thesis Award (UC Berkeley)                        |
| 1984                                                          | IEEE Centennial Outstanding Young Engineer Award (One-time award). |
| 1987                                                          | ONR Presidential Young Investigator                                |
| 1987                                                          | NSF Presidential Young Investigator                                |
| 2004                                                          | IEEE Control Systems Field Award                                   |
| Various National and world athletic records and championships |                                                                    |

### Recent publications

1. H. Sandberg, J. C. Delvenne, J. C. Doyle. (2011) On Lossless Approximations, the Fluctuation-Dissipation Theorem, and Limitations of Measurements, *IEEE Trans Auto Control*, Feb 2011
2. J Lavaei, A Babakhani, A Hajimiri, and JC Doyle (2011), Solving Large-Scale Hybrid Circuit-Antenna Problems, *IEEE Transactions on Circuits and Systems I*, vol. 58, no. 2, pp. 374-387, Feb. 2011.
3. G. Buzi, U. Topcu, J. Doyle. (2011) Analysis of autocatalytic networks in biology, *Automatica*, vol. 47, pp. 1123-1130,
4. Chandra F, Buzi G, Doyle JC (2011) Glycolytic oscillations and limits on robust efficiency. *Science*, Vol 333, pp 187-192.
5. JC Doyle, ME Csete (2011) Architecture, Constraints, and Behavior, *P Natl Acad Sci USA*, vol. 108, Sup 3 15624-15630
6. Gayme DF, McKeon BJ, Bamieh B, Papachristodoulou P, Doyle JC (2011) Amplification and Nonlinear Mechanisms in Plane Couette Flow, *Physics of Fluids*, V23, Issue 6, 065108
7. Page, M. T., D. Alderson, and J. Doyle (2011), The magnitude distribution of earthquakes near Southern California faults, *J. Geophys. Res.*, 116, B12309, doi:10.1029/2010JB007933.
8. Namas R, Zamora R, An, G, Doyle, J et al, (2012) Sepsis: Something old, something new, and a systems view, *Journal Of Critical Care* Volume: 27 Issue: 3
9. Chen, L; Ho, T; Chiang, M, Low S; Doyle J, (2012) Congestion Control for Multicast Flows With Network Coding, *IEEE Trans On Information Theory* Volume: 58 Issue: 9 Pages: 5908-5921

### Other selected publications since 2000

10. Yi TM, Huang Y, Simon MI, Doyle J (2000) Robust perfect adaptation in bacterial chemotaxis through integral feedback control. *Proc Natl Acad Sci USA* 97:4649-4653.
11. Carlson JM, Doyle J, Complexity and robustness, *P Natl Acad Sci USA* 99: 2538-2545 Suppl. 1 FEB 19 2002
12. M. E. Csete and J. C. Doyle. Reverse engineering of biological complexity. *Science* 295(5560):1664-1669 (2002).
13. Low SH, Paganini F, Doyle JC, Internet congestion control, *IEEE Contr Syst Mag* 22 (1): 28-43 FEB 2002
14. Csete M.E. and J.C. Doyle, 2004, Bow ties, metabolism, and disease, *Trends in Biotechnology*, Vol 22, Issue 9, pg. 446-450
15. J. Stelling, U. Sauer, Z. Szallasi, F. J. Doyle III, and J. Doyle, 2004, Robustness of cellular functions, *Cell*, October, 2004.
16. H. El-Samad, H. Kurata, J.C. Doyle, C.A. Gross, and M. Khammash, (2005), Surviving Heat Shock: Control Strategies for Robustness and Performance, *PNAS* 102(8): FEB 22, 2005
17. Jin C, Wei D, Low SH, Bunn J, Choe HD, Doyle JC, et al (2005), FAST TCP: From theory to experiments *IEEE NETWORK* 19 (1): 4-11 JAN-FEB 2005
18. Paganini F, Wang ZK, Doyle JC, et al. Congestion control for high performance, stability, and fairness in general networks, *IEEE-ACM TRANSACTIONS ON NETWORKING* 13 (1): 43-56 FEB 2005
19. J. Doyle and M. Csete (2005). Motifs, stability, and control. *PLOS Biology*, 3, 2005.
20. Wang JT, Li L, Low SH, Doyle JC. (2005) Cross-layer optimization in TCP/IP networks, *IEEE-ACM TRANS ON NETWORKING* 13 (3): 582-595 JUN 2005
21. R. Tanaka, T-M Yi, and J. Doyle (2005) Some protein interaction data do not exhibit power law statistics, *FEBS letters*, 579 (23): 5140-5144 SEP 26 2005
22. Doyle et al, (2005), The "Robust Yet Fragile" Nature of the Internet, *PNAS* 102 (41), October 11, 2005
23. MA Moritz, ME Morais, LA Summerell, JM Carlson, J Doyle (2005) Wildfires, complexity, and highly optimized tolerance, *PNAS*, 102 (50) December 13, 2005; ,
24. L Li, D Alderson, JC Doyle, W Willinger (2006) Towards a Theory of Scale-Free Graphs: Definition, Properties, and Implications, *Internet Math*, Vol. 2, No. 4, 2006
25. H El-Samad, A Papachristodoulou, S Prajna, J Doyle, and M Khammash (2006), Advanced Methods and Algorithms for Biological Networks Analysis, *PROCEEDINGS OF THE IEEE*, 94 (4): 832-853
26. Kurata, H El-Samad, R Iwasaki, H Ohtake, JC Doyle, et al. (2006) Module-based analysis of robustness tradeoffs in the heat shock response system. *PLoS Comput Biol* 2(7): July 2006
27. M Chiang, SH Low, AR Calderbank, JC. Doyle (2006) Layering As Optimization Decomposition, *PROCEEDINGS OF THE IEEE*, Volume: 95 Issue: 1 Jan 2007
28. Martins NC, Dahleh MA, Doyle JC (2007) Fundamental Limitations of Disturbance Attenuation in the Presence of Side Information, *IEEE Trans Auto Control*, Feb 2007
29. Doyle J, and Csete M, Rules of engagement. *NATURE* 446 (7138): 860-860 APR 19 2007 (PMID: 17443168)
30. Bowman, Balch, Artaxo, Bond, Carlson, Cochrane, D'Antonio, DeFries, Doyle, et al. Fire in the Earth System, *Science*, Vol. 324 no. 5926 pp. 481-484 24 April 2009
31. Willinger W, Alderson D, and Doyle JC (2009) Mathematics and the internet: A source of enormous confusion and great potential. *Notices Amer Math Soc* 56:586-599.
32. Alderson DL, Doyle JC (2010) Contrasting views of complexity and their implications for network-centric infrastructures. *IEEE Trans Systems Man Cybernetics—Part A: Syst Humans* 40:839-852.
33. Gayme DF, McKeon BJ, Papachristodoulou P, Bamieh B, Doyle JC (2010) A streamwise constant model of turbulence in plane Couette flow, *J Fluid Mech*, vol 665, pp 99-119

### Selected older publications 1978-1991

1. Packard A, Doyle J, (1991) The Complex Structured Singular Value, *Automatica* Vol: 29 Issue: 1 Pages: 71-109
2. J. Doyle, K. Glover, P. Khargonekar, and B. Francis, State-space solutions to standard  $H_2$  and  $H_\infty$  optimal control problems, *IEEE Trans. Auto. Control*, August, 1989
3. Doyle JC (1982) Analysis of Feedback-Systems with Structured Uncertainties, *IEE Proceedings-D Control Theory and Applications* Volume: 129 Issue: 6 Pages: 242-250
4. Doyle JC, Stein G (1981), Multivariable Feedback Design - Concepts For A Classical-Modern Synthesis *IEEE Transactions On Automatic Control* Vol: 26 Issue: 1 Pages: 4-16
5. Doyle JC (1978) Guaranteed Margins for LQG Regulators, *IEEE Transactions On Automatic Control*, Vol: 23 Issue: 4 Pages: 756-757