
References

- [1] Special issue on system identification for robust control design. *IEEE Transactions on Automatic Control*, vol. 37, no. 7 (July 1992).
- [2] ACKERMANN, J. *Robust Control: Systems with Uncertain Physical Parameters*. Springer-Verlag, New York, NY, 1993.
- [3] ADCOCK, J. L. Curve fitter for pole - zero analysis. *Hewlett - Packard Journal* (January 1987).
- [4] AGUIRRE, G., CHAPELLAT, H., AND BHATTACHARYYA, S. P. Stability margins for discrete-time uncertain systems. In *Proceedings of the 1989 IEEE Conference on Decision and Control* (Tampa, FL, December 1989).
- [5] AHMAD, S. S. AND KEEL, L. H. Robust lead-lag compensation for uncertain linear systems. In *Proceedings of the 1992 IEEE Symposium on Circuits and Systems* (San Diego, CA, 1992), pp. 2716 – 2719.
- [6] AHMAD, S. S., KEEL, L. H., AND BHATTACHARYYA, S. P. Computer aided robust control design for interval control system. In *Proceedings of the IEEE Symposium on Computer Aided Control System Design* (Napa, CA, 1992), pp. 82 – 89.
- [7] AHMAD, S. S., KEEL, L. H., AND BHATTACHARYYA, S. P. Robust PID control and lead-lag compensator for linear interval systems. In *Robustness of Dynamic Systems with Parameter Uncertainties*, M. Mansour, S. Balemi, and W. Truöl, Eds. Birkhäuser, Berlin, 1992, pp. 251 – 260.
- [8] AHMAD, S. S., KEEL, L. H., AND BHATTACHARYYA, S. P. Frequency domain templates for design of multilinear interval control systems. Tech. Rep., Tennessee State University, January 1994. ISE Report No. ACS-94-1.
- [9] AIZERMAN, M. A. AND GANTMACHER, F. R. *Absolute stability of regulator systems*. Holden-Day Publishing Co., San Francisco, CA, 1964. Russian Edition, 1963.

-
- [10] ANDERSON, B. D. O., KRAUS, F., MANSOUR, M., AND DASGUPTA, S. Easily testable sufficient conditions for the robust stability of systems with multi-affine parameter dependence. In *Robustness of Dynamic Systems with Parameter Uncertainties*, M. Mansour, S. Balemi, and W. Truöl, Eds. Birkhäuser, Berlin, 1992, pp. 81 – 92.
- [11] BARMISH, B. R. Invariance of strict Hurwitz property of polynomials with perturbed coefficients. *IEEE Transactions on Automatic Control*, vol. AC-29, no. 10 (October 1984), pp. 935 – 936.
- [12] BARMISH, B. R. New tools for robustness analysis. In *Proceedings of the 27th IEEE Conference on Decision and Control* (Austin, TX, December 1988), pp. 1 – 6.
- [13] BARMISH, B. R. A generalization of Kharitonov’s four polynomial concept for robust stability problems with linearly dependent coefficient perturbations. *IEEE Transactions on Automatic Control*, vol. 34, no. 2 (February 1989), pp. 157 – 165.
- [14] BARMISH, B. R. *New Tools for Robustness of Linear Systems*. Macmillan Publishing Co., New York, NY, 1994.
- [15] BARMISH, B. R., HOLLOT, C. V., KRAUS, F. J., AND TEMPO, R. Extreme point results for robust stabilization of interval plants with first order compensators. *IEEE Transactions on Automatic Control*, vol. 37, no. 6 (June 1992), pp. 707 – 714.
- [16] BARMISH, B. R., KHARGONEKAR, P. P., SHI, Z., AND TEMPO, R. Robustness margin need not be a continuous function of the problem data. *Systems & Control Letters*, vol. 15 (1989), pp. 371 – 381.
- [17] BARMISH, B. R. AND SHI, Z. Robust stability of a class of polynomials with coefficients depending multilinearly on perturbations. *IEEE Transactions on Automatic Control*, vol. AC-35, no. 9 (September 1990), pp. 1040 – 1043.
- [18] BARMISH, B. R. AND WEI, K. H. Simultaneous stabilization of single input single output systems. In *Proceedings of the International Symposium on Mathematical Theory of Networks and Systems* (Stockholm, Sweden, 1985).
- [19] BARTLETT, A. C. Nyquist, Bode, and Nichols plots of uncertain systems. In *Proceedings of the 1990 American Control Conference* (San Diego, CA, 1990), pp. 2033 – 2036.
- [20] BARTLETT, A. C. Vertex results for the steady state analysis of uncertain systems. *IEEE Transactions on Automatic Control*, vol. 37, no. 11 (November 1992), pp. 1758 – 1762.

- [21] BARTLETT, A. C., HOLLOT, C. V., AND LIN, H. Root location of an entire polytope of polynomials: it suffices to check the edges. *Mathematics of Controls, Signals and Systems*, vol. 1 (1988), pp. 61 – 71.
- [22] BARTLETT, A. C., TESI, A., AND VICINO, A. Frequency response of uncertain systems with interval plants. *IEEE Transactions on Automatic Control*, vol. 38, no. 6 (June 1993), pp. 929 – 933.
- [23] BASU, S. On boundary implications of stability and positivity properties of multidimensional systems. *IEEE Proceedings*, vol. 78, no. 4 (April, 1990), pp. 614 – 626.
- [24] BAYARD, D. S., HADAEGH, F. Y., YAM, Y., SCHEID, R. E., METTLER, E., AND MILMAN, M. H. Automated on-orbit frequency domain identification for large space structures. *Automatica*, vol. 27, no. 6 (November 1991), pp. 931 – 946.
- [25] BELLMAN, R. E. The theory of dynamic programming. *Proceedings of National Academy of Science, USA*, vol. 38 (1954), pp. 716 – 719.
- [26] BELLMAN, R. E. *Introduction to the Mathematical Theory of Control Processes, Vol. 1*. Academic Press, New York, NY, 1967.
- [27] BERMAN, A. AND PLEMMONS, R. J. *Nonnegative Matrices in the Mathematical Science*. Academic Press, New York, NY, 1979.
- [28] BHATTACHARYA, S., KEEL, L. H., AND BHATTACHARYYA, S. P. Robust stabilizer synthesis for interval plants using H_∞ methods. In *Proceedings of the 1993 IEEE Conference on Decision and Control* (San Antonio, Texas, December 1993), pp. 3003 – 3008.
- [29] BHATTACHARYYA, S. P. *Robust stabilization against structured perturbations*. Lecture Notes in Control and Information Sciences, vol. 99, Springer-Verlag, New York, NY, 1987.
- [30] BHATTACHARYYA, S. P. Robust parametric stability: The role of the CB segments. In *Control of Uncertain Dynamic Systems*, S. P. Bhattacharyya and L. H. Keel, Eds. CRC Press, Littleton, MA, 1991, pp. 381 – 402.
- [31] BHATTACHARYYA, S. P. Vertex results in robust stability. Tech. Rep., TCSP Report, Texas A&M University, April 1991.
- [32] BHATTACHARYYA, S. P. AND KEEL, L. H., Eds. *Control of Uncertain Dynamic Systems*. CRC Press, Littleton, MA, 1991.
- [33] BHATTACHARYYA, S. P. AND KEEL, L. H. Robust stability and control of linear and multilinear interval systems. In *Control and Dynamic Systems*, C. T. Leondes, Ed., vol. 51. Academic Press, New York, NY, 1992, pp. 31 – 78.

- [34] BHATTACHARYYA, S. P., KEEL, L. H., AND HOWZE, J. W. Stabilization of linear systems with fixed order controllers. *Linear Algebra and its Applications*, vol. 98 (1988), pp. 57 – 76.
- [35] BHATTACHARYYA, S. P. AND PEARSON, J. B. On the linear servomechanism problem. *International Journal of Control*, vol. 12, no. 5 (1970), pp. 795 – 806.
- [36] BHATTACHARYYA, S. P. AND PEARSON, J. B. On error systems and the servomechanism problem. *International Journal of Control*, vol. 15, no. 6 (1972), pp. 1041 – 1062.
- [37] BHATTACHARYYA, S. P., PEARSON, J. B., AND WONHAM, W. M. On zeroing the output of a linear system. *Information and Control*, vol. 2 (1972), pp. 135 – 142.
- [38] BIALAS, S. A necessary and sufficient condition for stability of interval matrices. *International Journal of Control*, vol. 37 (1983), pp. 717 – 722.
- [39] BIALAS, S. A necessary and sufficient condition for the stability of convex combinations of stable polynomials and matrices. *Bulletin of Polish Academy of Science*, vol. 33 (1985), pp. 473 – 480.
- [40] BIERNACKI, R. M., HWANG, H., AND BHATTACHARYYA, S. P. Robust stabilization of plants subject to structured real parameter perturbations. *IEEE Transactions on Automatic Control*, vol. AC-32, no. 6 (June 1987), pp. 495 – 506.
- [41] BLONDEL, V. *Simultaneous Stabilization of Linear Systems*. Lecture Notes in Control and Information Sciences, Springer-Verlag, New York, NY, 1994.
- [42] BODE, H. W. *Network Analysis and Feedback Amplifier Design*. D. Van Nostrand Publishing Co., New York, NY, 1945.
- [43] BOSE, N. K. *Digital Filters*. Elsevier-Science North-Holland, Krieger Publishing Co., New York, NY, 1993.
- [44] BOSE, N. K. A system-theoretic approach to stability of sets of polynomials. *Contemporary Mathematics*, vol. 47 (1985), pp. 25 – 34.
- [45] BOSE, N. K. Robust multivariable scattering Hurwitz interval polynomials. *Linear Algebra and its Application*, vol. 98 (1988), pp. 123 – 136.
- [46] BOSE, N. K. Test of Hurwitz and Schur properties of convex combination of complex polynomials. *IEEE Transactions on Automatic Control*, vol. 36, no. 9 (September 1989), pp. 1245 – 1247.

- [47] BOSE, N. K. Argument conditions for Hurwitz and Schur polynomials from network theory. *IEEE Transactions on Automatic Control*, vol. 39, no. 2 (February 1994), pp. 345 – 346.
- [48] BOSE, N. K. AND DELANSKY, J. F. Boundary implications for interval positive rational functions. *IEEE Transactions on Circuits and Systems*, vol. CAS-36 (1989), pp. 454 – 458.
- [49] BOSE, N. K. AND SHI, Y. Q. Network realizability theory approach to stability of complex polynomials. *IEEE Transactions on Automatic Control*, vol. 34, no. 2 (February 1987), pp. 216 – 218.
- [50] BOSE, N. K. AND SHI, Y. Q. A simple general proof of Kharitonov’s general stability criterion. *IEEE Transactions on Circuits and Systems*, vol. CAS-34 (1987), pp. 1233 – 1237.
- [51] BOYD, S. P. AND BARRATT, C. H. *Linear Controller Design: Limits of Performance*. Prentice-Hall Publishing Co., Englewood Cliffs, NJ, 1990.
- [52] BRASCH, F. M. AND PEARSON, J. B. Pole placement using dynamic compensator. *IEEE Transactions on Automatic Control*, vol. AC-15, no. 1 (February 1970), pp. 34 – 43.
- [53] CHANG, B. C. AND PEARSON, J. B. Optimal disturbance reduction in linear multivariable systems. *IEEE Transactions on Automatic Control*, vol. AC-29, no. 10 (October 1984), pp. 880 – 887.
- [54] CHAPPELLAT, H. Geometric conditions for robust stability. Master’s thesis, Department of Electrical Engineering, Texas A&M University, College Station, Texas, U.S.A., 1987.
- [55] CHAPPELLAT, H. *Robust stability and control under structured and unstructured perturbations*. PhD thesis, Department of Electrical Engineering, Texas A&M University, College Station, Texas, U.S.A., 1990.
- [56] CHAPPELLAT, H. AND BHATTACHARYYA, S. P. Calculation of maximal stability domains using an optimal property of Kharitonov polynomials. In *Analysis and Optimization of Systems*. Lecture Notes in Control and Information Sciences, vol. 62, Springer-Verlag, 1988, pp. 22 – 31.
- [57] CHAPPELLAT, H. AND BHATTACHARYYA, S. P. An alternative proof of Kharitonov’s theorem. *IEEE Transactions on Automatic Control*, vol. AC-34, no. 4 (April 1989), pp. 448 – 450.
- [58] CHAPPELLAT, H. AND BHATTACHARYYA, S. P. A generalization of Kharitonov’s theorem: robust stability of interval plants. *IEEE Transactions on Automatic Control*, vol. AC-34, no. 3 (March 1989), pp. 306 – 311.

- [59] CHAPPELLAT, H. AND BHATTACHARYYA, S. P. Robust stability and stabilization of interval plants. In *Robustness in Identification and Control*, M. Milanese, R. Tempo, and A. Vicino, Eds. Plenum Press, New York, NY, 1989, pp. 207 – 229.
- [60] CHAPPELLAT, H. AND BHATTACHARYYA, S. P. Simultaneous strong stabilization. Tech. Rep., EE Department Report, Texas A&M University, 1989.
- [61] CHAPPELLAT, H., BHATTACHARYYA, S. P., AND DAHLEH, M. Robust stability of a family of disc polynomials. *International Journal of Control*, vol. 51 (1990), pp. 1353 – 1362.
- [62] CHAPPELLAT, H., BHATTACHARYYA, S. P., AND KEEL, L. H. Stability margin for Hurwitz polynomials. In *Proceedings of the 27th IEEE Conference on Decision and Control* (Austin, TX, December 1988), pp. 1392 – 1398.
- [63] CHAPPELLAT, H., DAHLEH, M., AND BHATTACHARYYA, S. P. Robust stability under structured and unstructured perturbations. *IEEE Transactions on Automatic Control*, vol. AC-35, no. 10 (October 1990), pp. 1100 – 1108.
- [64] CHAPPELLAT, H., DAHLEH, M., AND BHATTACHARYYA, S. P. On robust nonlinear stability of interval control systems. *IEEE Transactions on Automatic Control*, vol. AC-36, no. 1 (January 1991), pp. 59 – 67.
- [65] CHAPPELLAT, H., DAHLEH, M., AND BHATTACHARYYA, S. P. Robust stability manifolds for multilinear interval systems. *IEEE Transactions on Automatic Control*, vol. 38, no. 2 (February 1993), pp. 314 – 318.
- [66] CHAPPELLAT, H., KEEL, L. H., AND BHATTACHARYYA, S. P. Stability margins for multilinear interval control systems. In *Proceedings of the 30th IEEE Conference on Decision and Control* (Brighton, UK, December 1991), pp. 894 – 899.
- [67] CHAPPELLAT, H., KEEL, L. H., AND BHATTACHARYYA, S. P. Extremal robustness properties of multilinear interval systems. *Automatica*, vol. 30, no. 6 (June 1994), pp. 1037 – 1042.
- [68] CHAPPELLAT, H., MANSOUR, M., AND BHATTACHARYYA, S. P. Elementary proofs of some classical stability criteria. *IEEE Transactions on Education*, vol. 33, no. 3 (March 1990), pp. 232 – 239.
- [69] COHN, A. Über die anzahl der wurzein einer algebraischen gleichung in einem kreise. *Math. Zeit.*, vol. 14 (1922), pp. 110 – 148.
- [70] DAHLEH, M., TESI, A., AND VICINO, A. Robust stability and performance of interval plants. *Systems & Control Letters*, vol. 19 (1992), pp. 353 – 363.

- [71] DAHLEH, M., TESI, A., AND VICINO, A. On the robust Popov criterion for interval Lur'e system. *IEEE Transactions on Automatic Control*, vol. 38, no. 9 (September 1993), pp. 1400 – 1405.
- [72] DAHLEH, M., TESI, A., AND VICINO, A. An overview of extremal properties for robust control of interval plants. *Automatica*, vol. 29, no. 3 (May 1993), pp. 707 – 722.
- [73] DAHLEH, M. A. AND PEARSON, J. B. ℓ^1 optimal feedback controllers for MIMO discrete-time systems. *IEEE Transactions on Automatic Control*, vol. AC-32, no. 4 (April 1987), pp. 314 – 322.
- [74] DASGUPTA, S. A Kharitonov like theorem for systems under nonlinear passive feedback. In *Proceedings of the 26th IEEE Conference on Decision and Control* (Los Angeles, CA, December 1987), pp. 2062 – 2063.
- [75] DASGUPTA, S. Kharitonov's theorem revisited. *Systems & Control Letters*, vol. 11 (1988), pp. 381 – 384.
- [76] DASGUPTA, S. AND BHAGWAT, A. S. Conditions for designing strictly positive real transfer functions for adaptive output error identification. *IEEE Transactions on Circuits and Systems*, vol. CAS-34 (1987), pp. 731 – 736.
- [77] DATTA, A. AND BHATTACHARYYA, S. P. On a quantitative theory of robust adaptive control: an interval plant approach. In *Proceedings of the 1994 American Control Conference* (June 1994), pp. 58 – 62.
- [78] DATTA, A. AND BHATTACHARYYA, S. P. On determining the δ and θ -Hurwitz stability of interval polynomials. In *Proceedings of the 1995 American Control Conference* (June 1995), To appear.
- [79] DAVISON, E. J. The robust control of a servomechanism problem for linear time-invariant systems. *IEEE Transactions on Automatic Control*, vol. AC-21, no. 1 (January 1976), pp. 25 – 34.
- [80] DEGASTON, R. R. E. AND SAFONOV, M. G. Exact calculation of the multi-loop stability margin. *IEEE Transactions on Automatic Control*, vol. AC-33, no. 2 (February 1988), pp. 156 – 171.
- [81] DESOER, C. A., LIU, R. W., MURRAY, J., AND SAEKS, R. Feedback system design: The fractional representation approach to analysis and synthesis. *IEEE Transactions on Automatic Control*, vol. AC-25 (June 1980), pp. 399 – 412.
- [82] DIEUDONNÉ, J. *Eléments d'analyse, Tome 1: Fondements de l'analyse moderne*. Gauthier-Villars, Editeur, Paris, 1969.
- [83] DORATO, P., Ed. *Robust Control*. IEEE Press, New York, NY, 1987.

- [84] DORATO, P., ABDALLAH, C., AND CERONE, V. *Linear Quadratic Control: An Introduction*. Macmillan Publishing Co., New York, NY, 1994.
- [85] DORATO, P., FORTUNA, L., AND MUSCATO, G. *Robust Control for Unstructured Perturbations: An Introduction*. Lecture Notes in Control and Information Sciences, vol. 168, Springer-Verlag, New York, NY, 1992.
- [86] DORATO, P. AND YEDAVALI, R. K., Eds. *Recent Advances in Robust Control*. IEEE Press, New York, NY, 1989.
- [87] DOYLE, J. C. Guaranteed margins for LQG regulators. *IEEE Transactions on Automatic Control*, vol. AC-23, (August 1978), pp. 756 – 757.
- [88] DOYLE, J. C. Analysis of feedback systems with structured uncertainties. *Proceeding of IEE - D*, vol. 129, no. 6 (1982), pp. 242 – 250.
- [89] DOYLE, J. C. Synthesis of robust controllers and filters. In *Proceedings of the 22nd IEEE Conference on Decision and Control* (December 1983), pp. 109 – 114.
- [90] DOYLE, J. C. Structured uncertainty in control system design. In *Proceedings of the 24th IEEE Conference on Decision and Control* (Ft. Lauderdale, FL, December 1985), pp. 260 – 265.
- [91] DOYLE, J. C., GLOVER, K., KHARGONEKAR, P. P., AND FRANCIS, B. A. State space solution to standard H_2 and H_∞ control problems. *IEEE Transactions on Automatic Control*, vol. AC-34, no. 8 (August 1989), pp. 831 – 847.
- [92] FAEDO, S. A new stability problem for polynomials with real coefficients. *Ann. Scuola Norm. Sup. Pisa Sci. Fis. Mat. Ser. 3 - 7* (1953), pp. 53 – 63.
- [93] FERREIRA, P. M. G. The servomechanism problem and the method of the state space in the frequency domain. *International Journal of Control* 23, vol. 2 (1976), pp. 245 – 255.
- [94] FERREIRA, P. M. G. AND BHATTACHARYYA, S. P. On blocking zeros. *IEEE Transactions on Automatic Control*, vol. AC-22, no. 2 (1977), pp. 258 – 259.
- [95] FOO, Y. K. AND SOH, Y. C. Stability analysis of a family of matrices. *IEEE Transactions on Automatic Control*, vol. 35, no. 11 (November 1990), pp. 1257 – 1259.
- [96] FRANCIS, B. A. AND WONHAM, W. M. The internal model principle for linear multivariable regulators. *Applied Mathematics and Optimization*, vol. 2, no. 2 (1975), pp. 170 – 194.

- [97] FRANCIS, B. A. AND ZAMES, G. On H_∞ -optimal sensitivity theory for SISO feedback systems. *IEEE Transactions on Automatic Control*, vol. AC-29, no. 1 (January 1984), pp. 9 – 16.
- [98] FU, M. Computing the frequency response of linear systems with parametric perturbation. *Systems & Control Letters*, vol. 15 (1990), pp. 45 – 52.
- [99] FU, M. AND BARMISH, B. R. Polytopes and polynomials with zeros in a prescribed set. *IEEE Transactions on Automatic Control*, vol. 34, no. 5 (May 1989), pp. 544 – 546.
- [100] FU, M., OLBROT, A. W., AND POLIS, M. P. Robust stability for time-delay systems: The Edge theorem and graphical tests. *IEEE Transactions on Automatic Control*, vol. 34, no. 8 (August 1989), pp. 813 – 820.
- [101] GANTMACHER, F. R. *The Theory of Matrices, Vol. 2*. Chelsea Publishing Company, New York, NY, 1959.
- [102] GARCIA, E., WEBB, S., AND DUKE, J. Passive and active control of complex flexible structure using reaction mass actuators. *ASME Journal of Vibrations and Acoustics*, vol. 117, no. 1 (January 1995), To appear.
- [103] GLOVER, K. Robust stabilization of linear multivariable systems: relations to approximation. *International Journal Control*, vol. 43 (March 1986), pp. 741 – 766.
- [104] GRUJIĆ, L. T. AND PETKOVSKI, D. On robustness of Lur'e systems with multiple nonlinearities. *Automatica*, vol. 23 (1987), pp. 327 – 334.
- [105] GUILLEMIN, E. A. *The Mathematics of Circuit Analysis*. John Wiley & Sons, Inc., New York, NY, 1949.
- [106] HALE, J. K. *Functional Differential Equations*. Applied Mathematical Sciences, vol. 3, Springer-Verlag, New York, 1971.
- [107] HALLAUER, W. AND LAMBERSON, S. Experimental active vibration damping of a plane truss using hybrid actuation. In *Proceedings of the 30th AIAA/ASME/ASCE/AHX/ASC Structures, Structural Dynamics and Materials Conference* (Mobile, AL, 1989), pp. 80 – 89.
- [108] HAYKIN, S. *Adaptive Filter Theory*. Prentice-Hall publishing Co., Englewood Cliffs, NJ, 1986.
- [109] HERMITE, C. Sur le nombre de racines d'une équation algébrique comprise entre des limites données. *J. Reine Angew. Math.*, vol. 52 (1856), pp. 39 – 51.
- [110] HINRICHSSEN, D. AND MÅRTENSSON, B., Eds. *Control of Uncertain Systems*. Birkhäuser, Berlin, 1990.

- [111] HINRICHSSEN, D. AND PRITCHARD, A. J. New robustness results for linear systems under real perturbations. In *Proceedings of the 27th IEEE Conference on Decision and Control* (1988), pp. 1375 - 1379.
- [112] HINRICHSSEN, D. AND PRITCHARD, A. J. An application of state space methods to obtain explicit formulae for robustness measures of polynomials. In *Robustness in Identification and Control*, M. Milanese, R. Tempo, and A. Vicino, Eds. Plenum Publishing Co., New York, 1989, pp. 183 - 206.
- [113] HINRICHSSEN, D. AND PRITCHARD, A. J. Real and complex stability radii: a survey. In *Control of Uncertain Systems*, D. Hinrichsen and B. Mårtensson, Eds. Birkhäuser, 1990, pp. 119 - 162.
- [114] HINRICHSSEN, D. AND PRITCHARD, A. J. A robustness measure for linear systems under structured real parameter perturbations. Tech. rep., Institut für Dynamische Systeme, Bremen, Germany, 1991. Report No. 184.
- [115] HOLLOT, C. V. AND BARTLETT, A. C. Some discrete-time counterparts to Kharitonov's stability criterion for uncertain systems. *IEEE Transactions on Automatic Control*, vol. AC-31, no. 4 (April 1986), pp. 355 - 356.
- [116] HOLLOT, C. V. AND TEMPO, R. H_∞ performance of weighted interval plants: complete characterization of vertex results. In *Proceedings of the 1993 American Control Conference* (San Francisco, CA, 1993), pp. 617 - 619.
- [117] HOLLOT, C. V. AND TEMPO, R. On the Nyquist envelope of an interval plant family. *IEEE Transactions on Automatic Control*, vol. 39, no. 2 (February 1994), pp. 391 - 396.
- [118] HOLLOT, C. V. AND XU, Z. L. When is the image of a multilinear function a polytope? a conjecture. In *Proceedings of the 28th IEEE Conference on Decision and Control* (Tampa, FL, 1989), pp. 1890 - 1891.
- [119] HOLLOT, C. V. AND YANG, F. Robust stabilization of interval plants using lead or lag compensators. *Systems & Control Letters*, vol. 14 (1990), 9 - 12.
- [120] HOROWITZ, I. *Synthesis of Feedback Control Systems*. Academic Press, New York, NY, 1963.
- [121] HURWITZ, A. Über die bedingungen, unter welchen eine gleichung nur wurzeln mit negativen reellen teilen besitzt. *Math. Ann.*, vol. 46 (1895), pp. 273 - 284.
- [122] JUANG, J.-N. AND PAPPAS, R. S. An eigensystem realization algorithm for modal parameter identification and model reduction. *AIAA Journal of Guidance, Control, and Dynamics*, vol. 8, no. 5 (September-October 1985), pp. 620 - 627.

- [123] JUANG, J.-N., PHAN, M., AND HORTA, L. G. User's Guide for System/Observer/Controller Identification Toolbox. Tech. Rep., NASA Technical Memorandum 107566, 1992.
- [124] JURY, E. I. *Sampled-data Control Systems*. John Wiley & Sons, Inc., New York, NY, 1958.
- [125] KALMAN, R. E. Contribution to the theory of optimal control. *Bol. Soc. Matem. Mexicana* (1960), pp. 102 – 119.
- [126] KALMAN, R. E. On the general theory of control systems. In *Proceedings of the 1st IFAC Congress* (Moscow, USSR, 1960), vol. 1, Butterworth, London, 1961, pp. 481 – 492.
- [127] KALMAN, R. E. When is a linear control system optimal? *ASME Transactions Series D (Journal of Basic Engineering)* (1964), pp. 51 – 60.
- [128] KALMAN, R. E. AND BUCY, R. S. New results in linear filtering and prediction theory. *ASME Transactions (Journal of Basic Engineering)*, vol. 83 (1961), pp. 95 – 107.
- [129] KANG, H. I. *Extreme point results for robustness of control systems*. PhD thesis, Department of Electrical and Computer Engineering, University of Wisconsin, Madison, Wisconsin, U.S.A., 1992.
- [130] KATBAB, A. AND JURY, E. I. Robust Schur-stability of control systems with interval plants. *International Journal of Control*, vol. 51, no. 6 (1990), pp. 1343 – 1352.
- [131] KEEL, L. H. *Computer Aided Control System Design for Linear Time-invariant Systems*. PhD thesis, Department of Electrical Engineering, Texas A&M University, College Station, Texas, U.S.A., 1986.
- [132] KEEL, L. H. AND BHATTACHARYYA, S. P. Frequency domain design of interval controllers. In *Control of Uncertain Dynamic Systems*, S. P. Bhattacharyya and L. H. Keel, Eds. CRC Press, Littleton, MA, 1991, pp. 423 – 438.
- [133] KEEL, L. H. AND BHATTACHARYYA, S. P. Parametric stability margin for multilinear interval control systems. In *Proceedings of the 1993 American Control Conference* (San Francisco, CA, 1993), pp. 262 – 266.
- [134] KEEL, L. H. AND BHATTACHARYYA, S. P. Stability margin for multilinear interval systems via phase conditions: A unified approach. In *Proceedings of the 1993 American Control Conference* (San Francisco, CA, 1993), pp. 3112 – 3116.

- [135] KEEL, L. H. AND BHATTACHARYYA, S. P. Control system design for parametric uncertainty. *International Journal of Robust and Nonlinear Control*, vol. 4, no. 1 (January-February 1994), pp. 87 – 100.
- [136] KEEL, L. H. AND BHATTACHARYYA, S. P. Phase properties of Hurwitz polynomials and segments. Tech. Rep., Tennessee State University, November 1994. ISE Report No. ACS-94-2.
- [137] KEEL, L. H. AND BHATTACHARYYA, S. P. Robust parametric classical control design. *IEEE Transactions on Automatic Control*, vol. 39, no. 7 (July 1994), pp. 1524 – 1530.
- [138] KEEL, L. H. AND BHATTACHARYYA, S. P. Robust stability of interval matrices: a computational approach. *International Journal of Control* (1995), To appear.
- [139] KEEL, L. H., BHATTACHARYYA, S. P., AND HOWZE, J. W. Robust control with structured perturbations. *IEEE Transactions on Automatic Control*, vol. 33, no. 1 (January 1988), pp. 68 – 78.
- [140] KEEL, L. H., LEW, J.-S., AND BHATTACHARYYA, S. P. System identification using interval dynamic models. In *Proceedings of the 1994 American Control Conference* (Baltimore, MD, June 1994), pp. 1537 – 1542.
- [141] KEEL, L. H., LIM, K. B., AND JUANG, J.-N. Robust eigenvalue assignment with maximum tolerance to system uncertainties. *AIAA Journal of Guidance, Control, and Dynamics*, vol. 14, no. 3 (May-June 1991), pp. 615 – 620.
- [142] KEEL, L. H., SHAW, J., AND BHATTACHARYYA, S. P. Robust control of interval systems. In *Robust Control*. Lecture Notes in Control and Information Sciences, vol. 183, Springer-Verlag, Tokyo, Japan, 1992, pp. 24 – 31.
- [143] KHARITONOV, V. L. Asymptotic stability of an equilibrium position of a family of systems of linear differential equations. *Differential Uravnen*, vol. 14 (1978), pp. 2086 – 2088. Translation in *Differential Equations*, vol. 14, pp. 1483 - 1485, 1979.
- [144] KHARITONOV, V. L. The Routh-Hurwitz problem for families of polynomials and quasipolynomials. *Izvetiy Akademii Nauk Kazakhskoi SSR, Seria fizikomatematicheskaya*, vol. 26 (1979), pp. 69 – 79.
- [145] KHARITONOV, V. L. Interval stability of quasipolynomials. In *Control of Uncertain Dynamic Systems*, S. P. Bhattacharyya and L. H. Keel, Eds. CRC Press, Littleton, MA, 1991, pp. 439 – 446.
- [146] KHARITONOV, V. L. Robust stability of nested polynomial families. Tech. rep., institut für Dynamische Systeme, Universität Bremen, Germany, May 1994. Report No. 306.

- [147] KHARITONOV, V. L. AND ZHABKO, A. P. Robust stability of time delay systems. *IEEE Transactions on Automatic Control*, vol. 39, no. 12 (December 1994), pp. 2388 – 2397.
- [148] KIMURA, H. Robust stabilizability for a class of transfer functions. *IEEE Transactions on Automatic Control*, vol. AC-29, no. 9 (September 1984), pp. 788 – 793.
- [149] KOGAN, J. *Robust Stability and Convexity*. Springer-Verlag, New York, NY, 1994.
- [150] KOKAME, H. AND MORI, T. A Kharitonov-like theorem for interval polynomial matrices. *Systems & Control Letters*, vol. 16 (1991), pp. 107 – 116.
- [151] KOSUT, R. L., GOODWIN, G. C., AND POLIS, M. P. Introduction: Special issue on system identification for control design. *IEEE Transactions on Automatic Control*, vol. 37, no. 7 (July 1992), pp. 899 – 899.
- [152] KRAUS, F. J., ANDERSON, B. D. O., AND MANSOUR, M. Robust Schur polynomial stability and Kharitonov's theorem. *International Journal of Control*, vol. 47 (1988), pp. 1213 – 1225.
- [153] KRAUS, F. J. AND MANSOUR, M. On robust Schur stability of discrete systems. In *Proceedings of the 29th IEEE Conference on Decision and Control* (Honolulu, Hawaii, December 1990), pp. 421 – 422.
- [154] KRAUS, F. J., MANSOUR, M., AND ANDERSON, B. D. O. Robust stability of polynomials with multilinear parameter dependence. *International Journal of Control*, vol. 50 (1989), pp. 1745 – 1762.
- [155] KRAUS, F. J., MANSOUR, M., AND JURY, E. I. Robust Schur stability of interval polynomial. In *Proceedings of the IEEE Conference on Decision and Control* (Tampa, FL, 1989), pp. 1908 – 1910.
- [156] KUCERA, V. *Discrete Linear Control: The Polynomial Equation Approach*. John Wiley & Sons, Inc., New York, NY, 1979.
- [157] KWAKERNAAK, H. The polynomial approach to H_∞ optimal regulation. In *H_∞ -Control Theory*, Lecture Notes in Mathematics, vol. 1496, Springer-Verlag, Berlin, 1991, pp. 141 – 221.
- [158] LANCASTER, P. AND TISMENETSKY, M. *The Theory of Matrices with Applications*. Academic Press, San Diego, CA, 1985.
- [159] LEAL, M. A. AND GIBSON, J. S. A first-order Lyapunov robustness method for linear systems with uncertain parameters. *IEEE Transactions on Automatic Control*, vol. 35, no. 9 (September 1990), pp. 1068 – 1070.

- [160] LEVIN, B. J. *Distribution of zeros of entire functions*, vol. 5. American Mathematical Society, Providence, Rhode Island, 1980. Translation of Mathematical Monographs.
- [161] LEW, J.-S., KEEL, L. H., AND JUANG, J.-N. Quantification of model error via an interval model with nonparametric error bound. In *Proceedings of the 1993 AIAA Guidance, Navigation, and Control Conference* (Monterey, CA, August 1993), pp. 1254 – 1263.
- [162] LEW, J.-S., KEEL, L. H., AND JUANG, J.-N. Quantification of parametric uncertainty via an interval model. *AIAA Journal of Guidance, Control, and Dynamics*, vol. 17, no. 6, (November-December 1994), pp. 1212 – 1218
- [163] LEW, J.-S., LINK, T. L., GARCIA, E., AND KEEL, L. H. Interval model identification for flexible structures with uncertain parameters. In *Proceedings of the 1994 ASME Structures, Structural Dynamics, and Materials Conference* (Hilton Head, SC, April 1994), pp. 42 – 47.
- [164] LINK, T. L., LEW, J.-S., GARCIA, E., AND KEEL, L. H. Robustness verification for flexible structures via interval control systems. In *Proceedings of the 1994 AIAA Guidance, Navigation, and Control Conference* (Scottsdale, AZ, August 1994), pp. 252 – 260.
- [165] LURIE, A. I. *On some nonlinear problems in the theory of automatic control*. H. M. Stationary Office, London, 1957. Russian Edition, 1951.
- [166] MAC FARLANE, A. G. J. AND POSTLETHWAITE, I. The generalized Nyquist stability criterion and multivariable root-loci. *International Journal of Control*, vol. 25 (January 1977), pp. 81 – 127.
- [167] MACIEJOWSKI, J. M. *Multivariable Feedback Design*. Addison - Wesley, Reading, MA, 1988.
- [168] MANSOUR, M. Robust stability of interval matrices. In *Proceedings of the 28th IEEE Conference on Decision and Control* (Tampa, FL, December 1989), pp. 46 – 51.
- [169] MANSOUR, M. Robust stability in systems described by rational functions. In *Control and Dynamic Systems*, C. T. Leondes, Ed., vol. 51. Academic Press, New York, NY, 1992, pp. 79 – 128.
- [170] MANSOUR, M. On robust stability of linear systems. *Systems & Control Letters*, vol. 22 (1994), pp. 131 – 143.
- [171] MANSOUR, M. AND ANDERSON, B. D. O. Kharitonov's theorem and the second method of Lyapunov. In *Robustness of Dynamic Systems with Parameter Uncertainties*, M. Mansour, S. Balemi, and W. Truöl, Eds. Birkhäuser, Berlin, 1992, pp. 3 – 12.

- [172] MANSOUR, M., BALEMI, S., AND TRUÖL, W., Eds. *Robustness of Dynamic Systems with Parameter Uncertainties*. Birkhäuser, Berlin, 1992.
- [173] MANSOUR, M. AND KRAUS, F. J. Argument conditions for Hurwitz and Schur stable polynomials and the robust stability problem. Tech. rep., ETH, Zurich, Tech. Report, 1990.
- [174] MANSOUR, M., KRAUS, F. J., AND ANDERSON, B. D. O. Strong Kharitonov theorem for discrete systems. In *Robustness in Identification and Control*, M. Milanese, R. Tempo, and A. Vicino, Eds. Plenum Press, New York, NY, 1989.
- [175] MARDEN, M. *Geometry of Polynomial*. American Mathematical Society, Providence, RI, 1966.
- [176] MARQUEZ, H. J. AND DIDUCH, C. P. On strict positive realness of interval plants. *IEEE Transactions on Circuits and Systems*, vol. 40, no. 8 (August 1993), pp. 551 – 552.
- [177] MARTIN, J. M. State-space measures for stability robustness. *IEEE Transactions on Automatic Control*, vol. AC-32, no. 6 (June 1987), pp. 509 – 512.
- [178] MAXWELL, T. C. On governors. *Proceedings of the Royal Society*, vo. 16 (1868), pp. 270 – 283.
- [179] MERESSI, T., CHEN, D., AND PADEN, B. Application of Kharitonov's theorem to mechanical systems. *IEEE Transactions on Automatic Control*. vo. 38, no. 3 (March 1993), pp. 488 – 491.
- [180] MILANESE, M., TEMPO, R., AND VICINO, A., Eds. *Robustness in Identification and Control*. Prenum Press, New York, NY, 1989.
- [181] MINNICHELLI, R. J., ANAGNOST, J. J., AND DESOER, C. A. An elementary proof of Kharitonov's stability theorem with extensions. *IEEE Transactions on Automatic Control*, vol. AC-34, no. 9 (September 1989), pp. 995 – 998.
- [182] MORI, T. AND BARNETT, S. On stability tests for some classes of dynamical systems with perturbed coefficients. *IMA Journal of Mathematical Control and Information*, vol. 5 (1988), pp. 117 – 123.
- [183] MORI, T. AND KOKAME, H. Stability of interval polynomials with vanishing extreme coefficients. In *Recent Advances in Mathematical Theory of Systems, Control, Networks, and Signal Processing I*. Mita Press, Tokyo, Japan, 1992, pp. 409 – 414.
- [184] NYQUIST, H. Regeneration theory. *Bell System Technical Journal*, vol. 11 (1932), pp. 126 – 147.

- [185] PATEL, R. V. AND TODA, M. Quantitative measures of robustness for multivariable systems. In *Proceedings of American Control Conference* (San Francisco, CA, May 1980).
- [186] PATEL, V. V. AND DATTA, K. B. H_∞ -based synthesis for a robust controller of interval plants. *Automatica*, Submitted for publication.
- [187] PEARSON, J. B. Compensator design for dynamic optimization. *International Journal of Control*, vol. 9 (1968), pp. 473 – 473.
- [188] PÉREZ, F., ABDALLAH, C., AND DOCAMPO, D. Extreme point stability tests for discrete-time polynomials. In *Proceedings of the 31th IEEE Conference on Decision and Control* (Tucson, AZ, December 1992), pp. 1552 – 1553.
- [189] PETERSEN, I. R. A new extension to Kharitonov's theorem. In *Proceedings of IEEE Conference on Decision and Control* (Los Angeles, CA, December 1987), pp. 2070 – 2075.
- [190] POLYAK, B. T. Robustness analysis for multilinear perturbations. In *Robustness of Dynamic Systems with Parameter Uncertainties*, M. Mansour, S. Balemi, and W. Truöl, Eds. Birkhäuser, Berlin, 1992, pp. 93 – 104.
- [191] POLYAK, B. T. AND SHMULYIAN, S. B. Frequency domain criteria for robust stability of bivariate polynomials. *IEEE Transactions on Circuits and Systems*, vol. 41, no. 2 (February 1994), pp. 161 – 167.
- [192] PONTRJAGIN, L. S. On the zeros of some elementary transcendental functions. *Akad. Nauk SSSR Ser. Mat.*, vol. 6 (1942), pp. 115 – 134. English translation, American Mathematical Society Translation, vol. 2 (1955), pp. 95 – 110.
- [193] QIU, L., BERNHARDSSON, B., RANTZER, A., DAVISON, E. J., YOUNG, P. M., AND DOYLE, J. C. A formula for computation of the real stability radius. In *Proceedings of the 1993 IFAC World Congress* (Sidney, Australia, 1993).
- [194] RANTZER, A. Kharitonov's weak theorem holds if and only if the stability region and its reciprocal are convex. *International Journal of Robust and Nonlinear Control* (1992).
- [195] RANTZER, A. Stability conditions for polytopes of polynomials. *IEEE Transactions on Automatic Control*, vol. AC-37, no. 1 (January 1992), pp. 79–89.
- [196] RANTZER, A. AND MEGRETSKI, A. A convex parameterization of robustly stabilizing controllers. *IEEE Transactions on Automatic Control*, vol. 39, no. 9 (September 1994), pp. 1802 – 1808.
- [197] ROSENBRÖCK, H. H. *State Space and Multivariable Theory*. John Wiley & Sons, Inc., New York, NY, 1970.

- [198] ROUTH, E. J. *A Treatise on the Stability of a Given State of Motion*. Macmillan Publishing Co., London, 1877.
- [199] SAEKI, M. A method of robust stability analysis with highly structured uncertainties. *IEEE Transactions Automatic Control*, vol. AC-31, no. 10 (October 1986), pp. 925 – 940.
- [200] SAEKS, R. AND MURRAY, J. Fractional representation, algebraic geometry and the simultaneous stabilization problem. *IEEE Transactions on Automatic Control*, vol. AC-27, no. 8 (August 1982), pp. 895 – 903.
- [201] SAFONOV, M. G. AND VERMA, M. S. ℓ_∞ optimization and Hankel approximation. *IEEE Transactions on Automatic Control*, vol. AC-30, no. 3 (March 1985), pp. 279 – 280.
- [202] SCHUR, I. Über potenzreihen, die in innern des einheitkreises beschränkt sind. *J. Reine Angew. Math.*, vol. 147 (1918), pp. 205 – 232.
- [203] SCHUR, I. Über potenzreihen, die in innern des einheitkreises beschränkt sind. *J. Reine Angew. Math.*, vol. 148 (1918), pp. 122 – 145.
- [204] SEZER, M. E. AND ŠILJAK, D. D. A note on robust stability bounds. *IEEE Transactions on Automatic Control*, vol. 34, no. 11 (November 1989), pp. 1212 – 1215.
- [205] SEZER, M. E. AND ŠILJAK, D. D. On stability of interval matrices. *IEEE Transactions on Automatic Control*, vol. 39, no. 2 (1994), pp. 368 – 371.
- [206] SHAFAI, B. AND HOLLOT, C. V. Nonnegative stabilization of interval discrete systems. In *Control of Uncertain Dynamic Systems*, S. P. Bhattacharyya and L. H. Keel, Eds. CRC Press, Littleton, MA, 1991, pp. 471 – 490.
- [207] SHAFAI, B., KOTHANDARAMAN, M., AND CHEN, J. Real and complex stability radii for nonnegative and Metzlerian systems. In *Proceedings of the 1993 IEEE Conference on Decision and Control* (San Antonio, TX, 1993), pp. 3482 – 3484.
- [208] SHAFAI, B., PEREV, K., COWLEY, D., AND CHEHAB, Y. A necessary and sufficient condition for the stability of nonnegative interval discrete systems. *IEEE Transactions on Automatic Control*, vol. 36, no. 6 (1991), pp. 742 – 746.
- [209] SHAFAI, B. AND SOTIROV, G. Interval identification and robust control design: A new perspective. In *Proceedings of the 1991 IFAC Symposium on Design Methods for Control Systems* (Zurich, Switzerland, September 1991), pp. 246 – 251.

- [210] SIDERIS, A. AND SÁNCHEZ PEÑA, R. S. S. Fast computation of the multivariable stability margin for real interrelated uncertain parameters. *IEEE Transactions on Automatic Control*, vol. 34, no. 12 (December 1989), pp. 1272 – 1276.
- [211] ŠILJAK, D. D. *Nonlinear Systems: Parametric Analysis and Design*. John Wiley & Sons, Inc., New York, NY, 1969.
- [212] ŠILJAK, D. D. Parameter space methods for robust control design: a guided tour. *IEEE Transactions on Automatic Control*, vol. AC-34, no. 7 (July 1989), pp. 674 – 688.
- [213] ŠILJAK, D. D. Polytopes of nonnegative polynomials. In *Proceedings of the 1989 American Control Conference* (Pittsburgh, PA, June 1989), pp. 193 – 199.
- [214] SOH, C. B., BERGER, C. S., AND DABKE, K. P. On the stability properties of polynomials with perturbed coefficients. *IEEE Transactions on Automatic Control*, vol. AC-30, no. 10 (October 1985), pp. 1033 – 1036.
- [215] SOH, Y. C. AND FOO, Y. K. Generalized Edge Theorem. *Systems & Control Letters*, vol. 12 (1989), pp. 219 – 224.
- [216] SOH, Y. C. AND FOO, Y. K. A note on the Edge Theorem. *Systems & Control Letters*, vol. 15 (1990), pp. 41 – 43.
- [217] SOTIROV, G. AND SHAFAI, B. Interval identification of linear systems with bounded errors in both input and output variables. In *Proceedings of the 1991 IEEE Conference on Decision and Control* (Brighton, U.K., December 1991), pp. 648 – 649.
- [218] TESI, A. AND VICINO, A. A new fast algorithm for robust stability analysis of linear control systems with linearly correlated parametric uncertainty. *Systems & Control Letters*, vol. 13 (1989), pp. 321 – 329.
- [219] TESI, A. AND VICINO, A. Robust stability of state-space models with structured uncertainties. *IEEE Transactions on Automatic Control*, vol. 35, no. 2 (February 1990), pp. 191 – 195.
- [220] TESI, A. AND VICINO, A. Robustness analysis for linear dynamical systems with linearly correlated parameter uncertainties. *IEEE Transactions on Automatic Control*, vol. 35, no. 2 (February 1990), pp. 186 – 190.
- [221] TESI, A. AND VICINO, A. Kharitonov segments suffice for frequency response analysis of interval plant-controller families. In *Control of Uncertain Dynamic Systems*, S. P. Bhattacharyya and L. H. Keel, Eds. CRC Press, Littleton, MA, 1991, pp. 403 – 415.

- [222] TESI, A. AND VICINO, A. Robust absolute stability of Lur'e control systems in parameter space. *Automatica*, vol. 27, no. 2 (March 1991), pp. 147 – 151.
- [223] TESI, A. AND VICINO, A. Robust strict positive realness: new results for interval plant plus controller families. In *Proceedings of the 30th IEEE Conference on Decision and Control* (Brighton, UK, December 1991), pp. 421 – 426.
- [224] TIN, M. A. Discrete time robust control systems under structured perturbations: Stability manifolds and extremal properties. Master's thesis, Department of Electrical Engineering, Texas A&M University, College Station, Texas, U.S.A., 1992.
- [225] TSYPKIN, Y. Z. AND POLYAK, B. T. Frequency domain criteria for ℓ_p -robust stability of continuous linear systems. *IEEE Transactions on Automatic Control*, vol. AC-36, no. 12 (December 1991), pp. 1464 – 1469.
- [226] TSYPKIN, Y. Z. AND POLYAK, B. T. Frequency domain criterion for robust stability of polytope of polynomials. In *Control of Uncertain Dynamic Systems*, S. P. Bhattacharyya and L. H. Keel, Eds. CRC Press, Littleton, MA, 1991, pp. 491 – 499.
- [227] TSYPKIN, Y. Z. AND POLYAK, B. T. Robust absolute stability of continuous systems. In *Robustness of Dynamic Systems with Parameter Uncertainties*, M. Mansour, S. Balemi, and W. Truöl, Eds. Birkhäuser, Berlin, 1992, pp. 113 – 124.
- [228] VAIDYANATHAN, P. AND MITRA, S. K. A unified structural interpretation of some well-known stability test procedures for linear systems. *IEEE Proceedings*, vol. 75, no. 4 (April 1987), pp. 478 – 497.
- [229] VICINO, A. AND TESI, A. Regularity condition for the stability margin problem with linear dependent perturbations. *SIAM Journal on Control and Optimization*, vol. 33, no. 5 (May 1995), To appear.
- [230] VICINO, A., TESI, A., AND MILANESE, M. Computation of nonconservative stability perturbation bounds for systems with nonlinearly correlated uncertainties. *IEEE Transactions on Automatic Control*, vol. AC-35, no. 7 (July 1990), pp. 835 – 841.
- [231] VIDYASAGAR, M. *Nonlinear Systems Analysis*. Prentice-Hall Publishing Co., Englewood Cliffs, NJ, 1978.
- [232] VIDYASAGAR, M. *Control System Synthesis: A Factorization Approach*. MIT Press, Cambridge, MA, 1985.
- [233] VIDYASAGAR, M. Optimal rejection of persistent bounded disturbances. *IEEE Transactions on Automatic Control*, vol. AC-31, no. 6 (June 1986), pp. 527 – 534.

- [234] VIDYASAGAR, M. AND KIMURA, H. Robust controllers for uncertain linear multivariable systems. *Automatica*, vol. 22, no. 1 (January 1986), pp. 85 – 94.
- [235] VIDYASAGAR, M. AND VISWANSADHAM, N. Algebraic design techniques for reliable stabilization. *IEEE Transactions on Automatic Control*, vol. AC-27, no. 5 (October 1988), pp. 1085 – 1095.
- [236] WALSH, J. L. *Interpolation and Approximation by Rational Function in the Complex Domain*. American Mathematical Society, 1935.
- [237] WONHAM, W. M. *Linear Multivariable Control: a Geometric Approach, 3rd Edition*. Springer-Verlag, New York, NY, 1985.
- [238] YEDAVALLI, R. K. Improved measures of stability for linear state space model. *IEEE Transactions on Automatic Control*, vol. AC-30, no. 6 (June 1985), pp. 577 – 579.
- [239] YEDAVALLI, R. K. AND LIANG, Z. Reduced conservatism in stability robustness bounds by state transformation. *IEEE Transactions on Automatic Control*, vol. AC-31, no. 9 (September 1986), pp. 863 – 865.
- [240] YEUNG, K. S. AND WANG, S. S. A simple proof of Kharitonov's theorem. *IEEE Transactions on Automatic Control*, vol. 32, no. 4 (April 1987), pp. 822 – 823.
- [241] YOULA, D. C., JABR, H. A., AND BONGIORNO, J. J. Modern Wiener - Hopf design of optimal controllers - Part I: The single input single output case. *IEEE Transactions on Automatic Control*, vol. AC-21, no. 1, (February 1976), pp. 3 – 13.
- [242] YOULA, D. C., JABR, H. A., AND BONGIORNO, J. J. Modern Wiener - Hopf design of optimal controllers - Part II: The multivariable case. *IEEE Transactions on Automatic Control*, vol. AC-21 (June 1976), pp. 319 – 338.
- [243] ZADEH, L. A. AND DESOER, C. A. *Linear Systems Theory*. McGraw Hill Book Co., New York, NY, 1963.
- [244] ZAMES, G. Functional analysis applied to nonlinear feedback systems. *IEEE Transactions on Circuit Theory*, vol. CT-10, (September 1963), pp. 392 – 404.
- [245] ZAMES, G. Feedback and optimal sensitivity: Model reference transformations, multiplicative seminorms, and approximate inverses. *IEEE Transactions on Automatic Control*, vol. AC-26, no. 2 (April 1981), pp. 301 – 320.
- [246] ZEHEB, E. Necessary and sufficient condition for the robust stability of a continuous systems: the continuous dependency case illustrated by multilinear dependence. *IEEE Transactions on Circuits and Systems*, vol. 37, no. 1 (January 1990), pp. 47 – 53.

- [247] ZHOU, K. AND KHARGONEKAR, P. P. Stability robustness bounds for linear state space models with structured uncertainty. *IEEE Transactions on Automatic Control*, vol. AC-32, no. 7 (July 1987), pp. 621 – 623.
- [248] ZIMMERMAN, D. C., HORNER, G. C., AND INMAN, D. J. Microprocessor controlled force actuator. *AIAA Journal of Guidance, Navigation, and Control*, vol. 11, no. 3 (May-June 1988), pp. 230 – 236.

Author Index

A

Ackermann, J. 29
Abdallah, C. 29, 268
Adcock, J. L. 614
Aguirre, G. 222, 385
Ahmad, S. S. 385, 507
Aizerman, M. A. 431
Anagnost, J. J. 267
Anderson, B. D. O. 267, 459, 507

B

Balemi, S. 29
Barmish, B. R. 29, 120, 222, 267,
268, 330, 507, 581
Barnett, S. 431
Barratt, C. H. 29
Bartlett, A. C. 25, 222, 268, 269,
291, 385
Basu, S. 268
Bayard, D. S. 614
Bellman, R. E. 19
Berger, C. S. 24, 163
Berman, A. 536
Bernhardsson, B. 536
Bhagwat, A. S. 431
Bhattacharya, S. 581
Bhattacharyya, S. P. 21, 25, 29, 70,
120, 163, 222, 267, 268, 329,
330, 385, 431, 459, 506, 507,
536, 536, 581, 615
Bialas, S. 120, 267

Biernacki, R. M. 25, 222
Blondel, V. 581
Bode, H. W. 18, 23
Bongiorno, J. J. 22
Bose, N. K. 70, 120, 267, 268, 431
Boyd, S. P. 29
Brasch, F. M. 21
Bucy, R. S. 19

C

Cerone, V. 29
Chang, B. C. 23
Chapellat, H. 25, 29, 70, 120, 163,
222, 267, 268, 329, 431, 506,
507, 581
Chehab, Y. 536
Chen, D. 268
Chen, J. 537
Cohn, C. 18
Cowley, D. 536

D

Dabke, K. P. 24, 163
Dahleh, M. 163, 431, 506, 507
Dahleh, M. A. 23
Dasgupta, S. 267, 431, 459
Datta, A. 330
Datta, K. B. 581
Davison, E. J. 21, 587
DeGaston, R. R. E. 222

Delansky, J. F. 431
Desoer, C. A. 22, 25, 267, 459
Diduch, C. P. 431
Dieudonné, J. 69
Docampo, D. 268
Dorato, P. 29, 581
Doyle, J. C. 22, 23, 536, 581
Duke, J. 615

F

Faedo, S. 267
Ferreira, P. M. G. 21
Foo, Y. K. 222, 536
Fortuna, L. 29, 581
Francis, B. A. 21, 23, 581
Fu, M. 222, 385

G

Gantmacher, F. R. 70, 431
Garcia, E. 615
Gibson, J. S. 536
Glover, K. 23, 581
Goodwin, G. C. 614
Grujić, Lj. T. 431
Guillemin, E. A. 70

H

Hale, J. K. 70
Hadaegh, F. Y. 614
Hallauer, W. 615
Haykin, S. 70
Hermite, C. 17
Hinrichsen, D. 29, 222, 536
Hollot, C. V. 25, 120, 222, 268, 291,
330, 385, 431, 459, 537
Horner, G. C. 615
Horowitz, I. R. 22, 24
Horta, L. G. 615
Howze, J. W. 163, 536
Hurwitz, A. 18
Hwang, H. 25, 222

I

Inman, D. J. 615

J

Jabr, H. A. 22
Juang, J.-N. 614, 615
Jury, E. I. 268, 330

K

Kalman, R. E. 19, 20
Kang, H. I. 120
Katbab, A. 330
Keel, L. H. 29, 120, 163, 222, 329,
385, 459, 506, 507, 536, 581,
615
Khargonekar, P. P. 23, 222, 536, 581
Kharitonov, V. L. 24, 120, 222, 267,
292, 330
Kimura, H. 23
Kogan, J. 163, 222
Kokame, H. 268, 507
Kosut, R. L. 614
Kothandaraman, M. 536
Kraus, F. J. 120, 267, 268, 330, 459,
507
Kucera, V. 22
Kwakernaak, H. 581

L

Lamberson, S. 615
Lancaster, P. 536
Leal, M. A. 536
Levin, B. Ja. 70
Lew, J.-S. 615
Liang, Z. 536
Lim, K. B. 536
Lin, H. 291
Link, T. L. 615
Liu, R. W. 22
Lur'e, A. I. 431

M

Mac Farlane, A. G. J. 22
Maciejowski, J. M. 29
Marden, M. 69, 70, 581
Marquez, H. J. 431
Mansour, M. 29, 70, 120, 163, 267,
268, 459, 507, 536
Mårtensson, B. 29
Martin, J. M. 536
Maxwell, T. C. 17
Megretski, A. 581
Meressi, T. 268
Mettler, E. 615
Milanese, M. 29, 222, 459
Milman, M. H. 615
Minnichelli, R. J. 267
Mitra, S. K. 70
Mori, T. 268, 431, 507
Murray, J. 22, 581
Muscato, G. 29, 581

N

Nyquist, H. 18

O

Olbrot, A. W. 222

P

Paden, B. 268
Pappa, R. S. 614
Patel, R. V. 536
Patel, V. V. 581
Pearson, J. B. 21, 23
Perev, K. 536
Pérez, F. 268
Peterson, I. R. 120
Petkovski, Dj. 431
Phan, M. 615
Plemmons, R. J. 536
Polis, M. P.i 222, 614
Polyak, B. T. 25, 163, 222, 431, 459

Pontryagin, L. S. 19, 63
Postlethwaite, I. 22
Pritchard, A. 222, 536

Q

Qiu, L. 536

R

Rosenbrock, H. H. 22
Rantzer, A. 120, 268, 536, 581
Routh, E. J. 18

S

Saeki, M. 507
Sacks, R. 22, 581
Safonov, M. G. 23, 222, 459
Sánchez Peña, R. S. 222, 459
Scheid, R. E. 615
Schur, I. 18
Sezer, M. E. 536
Shafai, B. 537, 615
Shaw, J. 385
Shi, Y. Q. 70
Shi, Z. 222, 267, 507
Shmulyian, S. B. 163
Sideris, A. 222, 459
Šiljak, D. D. 24, 29, 431, 536, 536
Soh, C. B. 24, 163
Soh, Y. C. 222, 536
Sotirov, G. 615

T

Tempo, R. 29, 222, 330, 385, 431
Tesi, A. 222, 385, 431, 459, 507, 536
Tin, M. A. 120
Tismenetsky, M. 537
Toda, M. 536
Truöl, W. 29
Tsyppkin, Ya. Z. 25, 163, 222, 431

V

- Vaidyanathan, P. 70
Verma, M. S. 23
Vicino, A. 29, 222, 385, 431, 459,
507, 536
Vidyasagar, M. 23, 29, 431, 581
Viswanadham N. 581

W

- Walsh, J.L. 581
Wang, S. S. 267
Webb, S. 615
Wei, K. H. 581
Wonham, W. M. 21, 22

X

- Xu, Z. L. 459

Y

- Yam, Y. 615
Yang, F. 120
Yedavalli, R. K. 29, 536
Yeung, K. S. 267
Young, P. M. 536
Youla, D. C. 22

Z

- Zadeh, L. A. 25, 459
Zames, G. 19, 23, 431
Zeheb, E. 120, 507
Zhabko, A. P. 120, 330
Zhou, K. 536
Zimmerman, D. C. 615

Subject Index

σ -Hurwitz 320
 θ -Hurwitz 324

A

absolute stability 386, 406
 of interval systems, 422
 of interval control systems, 423

absolute stability problem, 13, 406
 robust, 421

actuator dynamics
 of 10 bay truss structure, 608

additive perturbations 15, 543
alternating Hurwitz minor conditions
 120
antiHurwitz 93, 95, 113, 300, 334,
 530
antiSchur 115

B

Banach space theory 161
blocking zeros 22
Bode envelopes
 of interval systems, 345
 of multilinear interval systems, 480
Boundary Crossing Theorem 34

 for quasipolynomials, 65

boundary generating property
 linear, 338, 341
 multilinear (of extremal manifolds),
 467, 477

boundary properties 344
bounded degree 37
Bounded Phase Condition 73
 linear interval polynomials, 316
 multilinear interval polynomials,
 440, 468

Bounded Phase Lemma 72
Bounded Phase Theorem 188
Box Theorem 329

C

CB Theorem 330
characteristic polynomial 8
Circle Criterion 410, 411
 robust, 427
closed loop system 2
compact sets 540, 542
complementary sensitivity function 4,
 405
conservatism
 of envelopes, 350
 of Kharitonov Theorem, 293

control system 1
convex directions 72, 102
Convex Direction Lemma
 complex, 103
 real, 104
convex hull 184, 269, 434, 443
 approximation, 445
coprime 14, 284, 391, 579
coprimeness 282

D

degree dropping 37
dependencies 230, 269, 363 *Also See*
 multilinear interval polynomials
 multilinear, 434, 455, 465, 477
diagonal representation 489
 interval system, 490
 multilinear uncertainty, 494
disc polynomials,
 Hurwitz stability of, 151
 linear, 218
 robust stability of, 217
 Schur stability of, 154

E

edges 185, 187
 exposed, 271
 phases, 271
 root loci of, 282
 vertices, 185
Edge Theorem 271
Eigensystem Realization Algorithm (ERA)
 597
extensions of

boundary results, 477
edge results, 285

extremal

gain margins, 354
 H_∞ norms, 403
manifolds, 463
parametric stability margin, 355,
 472
phase margins, 354
segments, 299
sets, 299
stability margin, 353
systems, 333, 338, 359

extremal properties of

edges and vertices, 205, 206
Kharitonov polynomials, 242
mixed uncertainty systems, 502

F

Fenyves array 552
flexible structures 593
frequency domain
 envelopes, *See* Bode, Nyquist, Nichols
 templates, 28, 340
frequency domain property 331
 of multilinear interval system, 473
 of polytopic system, 362

G

gain margin 10
Generalized Kharitonov Theorem (GKT)
 300
 comparison with Edge Theorem,
 309
 for complex quasipolynomials, 319
 image set interpretation, 316

multilinear version of, 463
phase interpretation, 317

generalized Kharitonov segments, 299
guaranteed margin, *See* extremal margin, *Also See* worst case

H

H_∞ optimal control 14, 538
Hermite-Biehler Theorem 41
 complex Hurwitz polynomials, 48
 quasipolynomials, 63
 real Hurwitz polynomials, 41
 Schur polynomials, 52
 time-delay systems, 65
historical background 17
Hurwitz stability
 of multilinear polynomials, 462
hypersphere 122, 123, 169

I

identification 583
 interval system, 587, 589, 604
 nominal system, 585
image set approach 170
image set interpretation, *See* GKT
integral action 7
interlacing property 40
Interlacing Theorem, *See* Hermite-Biehler Theorem
Internal Model Principle 7, 21
internal stability 545
interpolation 549
interval identification and design, *See* identification
interval control system 333
 linear, 357

interval matrix
 robust stability, 511

interval polynomial 225
 linear, 296
 polynomial functions of, 253, 255
 Schur stability of, *See* Schur stability
 two parameter representation of, 238

interval polynomial matrix 466
interval system 233, 246
 diagonal representation of, *See* diagonal representation
 linear, 358
 modeling, *See* identification
 multilinear, 442
 robust stability bound, 574

inverse of
 line, 337
 polygon, 338

J

Jury stability test 26

K

Kharitonov polynomials 242, 247
 extremal properties of, 242
Kharitonov Theorem
 for real polynomials, 224
 for complex polynomials, 233
 interlacing interpretation of, 235
 image set based proof of, 239
Kharitonov
 boxes, 238

polynomials, *See* Kharitonov polynomials
 rectangle, *See* Kharitonov boxes
 vertices, 299
 segments, 297
 systems, 333

L

linear fractional transformation
 of interval system, 363

linear interval polynomials 296

LQR 19

Lur'e Criterion 408
 robust, 424

Lyapunov approach 518

Lyapunov equation 519

M

Mapping Theorem 435
 proof of, 435

MATLAB

Parametric Robust Control Tool-
 Box, 29
 Robust Control ToolBox, 569, 581
 ToolBox, 615

Matrix Fraction Description 22
 for interval elements, 434

matrix stability radius 525
 complex, 527
 real, 528, 531

Metzlerian matrices
 stability radius of, 530

Mini-Mast system 589

mixed perturbations 484,
 robust stability under, 485

mixed uncertainty 13

model validation 593

modeling *See* identification

monotonic phase property
 of Hurwitz polynomials, 40, 92,
 95

multiplicative perturbations 15, 548

multilinear interval polynomials 434,
 463
 dependencies between perturba-
 tions, 465

multilinear interval system 442, 474
 parametric stability margin, 446,
 472
 gain, phase, time-delay margins,
 H_∞ margin, 447

multiple interval systems 496

N

nested interval families 253

nested polytopic families 286

Nevanlinna - Pick
 interpolation, 550
 problem, 550

Nichols template (envelope)
 of interval systems, 346
 of multilinear interval systems, 480

nonlinear sector bounded
 feedback perturbations, 423
 margins 487

nonnegative matrices 529
 stability radius of, 330

Nyquist Criterion 9

Nyquist envelope
 interval systems, 344
 multilinear interval systems, 480

O

overbounding 437, 445, 553
optimal
 controller parameter selection, 376
 disturbance rejection problem, 23
 state feedback, 19

output regulator problem 21

P

parametric stability margin 165, 171, 355
parametric theory 24
performance 2
 robust, 402

Perron-Frobenius Theorem 532
perturbation, *See* uncertainty
phase properties 91
 of Hurwitz polynomials, 92, 93, 94, 95
 of segments, 99

phase margin 10
Pick matrix 551
polytope
 of complex polynomials, 199
 of polynomials, 187
 of quasipolynomials, 201

polytopic
 family, 185
 system, 270, 362

Popov Criterion 409
 robust, 426

Principle of the Argument 31
Projection Theorem
 Orthogonal, 121

Q

Q parametrization 545
Quantitative Feedback Theory (QFT)
 6

R

unity rank perturbation 510
rate of change of phase 95
reaction mass actuator (RMA) 598
refinement
 of convex hull approximation, 441

regulators, *See* servomechanisms
Riccati equation 568
robust
 lead-lag compensator, 369
 parametric classical control design, 366
 parametric stability, 251
 stability and performance, 2
 state feedback stabilization, 251

robust parametric stabilization 533
robust stabilization
 unstructured perturbation, 23, 547
 state space solution, 567

robustness 10, 20
robustification procedure 521
root
 clusters, *See* root space
 space, 271
 space boundary, 271

Rouché's Theorem 31

S

SBR function 550

Schur stability
of interval polynomials, 260

Schur stability test 57

segment
line segment, 72
polynomial, 81

Segment Lemma (Hurwitz) 70, 81

Schur Segment Lemma 83, 85, 91

sensitivity function 4

sensitivity minimization problem 23

Separation Principle 20

servomechanisms 2

simultaneous strong stabilization, 539,
541

Small Gain Theorem 15
for interval systems, 389
Robust, 398

SPR conditions
for interval systems 414

SPR property 408
characterization, 412
complex rational function, 419,
421
interval systems, 414, 416

stability
ball, *See* stability ball
hypersphere, 25, 125, 134
internal, 546, 547
robust, 9
strong, *See strong stability*

stability ball 24, 121
coefficient space, 123
parameter space, 169

characterization,
Hurwitz, 124, 126
monic case, 129
Schur, 132, 134
 l_p , 139

stability margin
 l_1 , 183
 l_2 , 174
 l_2 for time-delay systems, 179
 l_∞ , 183
 H_∞ , 394
discontinuity of, 179
parametric, *See* parametric sta-
bility margin
time-delay, *See* time-delay mar-
gin
unstructured, 399

stability radius, 25, 243, 445 *Also See*
matrix stability radius
complex, *See* complex stability ra-
dius
in coefficient space, *See* stability
margin
in parameter space, *See* stability
margin
 l_p , *See* stability margin
real, *See* real stability radius

state space
models, 9, 433
parameter perturbation, 509
representation, 265

steady state response 385
strong stability 72
structural dynamics
of 10 bay truss structure, 395

supporting hyperplane 270
symmetric-antisymmetric decomposi-
tion 85

T

templates, *See* frequency, uncertainty
 magnitude-phase, 345

time-delay margin, 451

tracking error 2

truss structure 582, 595

Tsytkin - Polyak Locus

ℓ_p locus, 141

 for polytopic systems, 214

U

uncertainty template 332, 334

uncertainty 10

 parametric, 11, 121, 165, 332,
 388, 421

 in state space model, *See* state
 space perturbation

 nonparametric, 13, 579

 norm-bounded, 28, 489, 501

 structured, 10 *Also See* paramet-
 ric uncertainty

 unstructured, 13, 166, 402

uncertainty blocks 452, 489, 526

uncertainty models 10

unity feedback 2, 4

V

value set 222 *Also See* image set

vertex 109

Vertex Lemma

 Hurwitz, 113

 Schur, 115

vibration suppression

 of a flexible structure, 601

Vertex results for H_∞ norms 403

W

worst case *Also See* extremal

 damping ratio, 280

 gain margin, phase margin, 247,
 331

H_∞ stability margin, 394

ℓ_2 stability margin, 207

 parametric stability margin, 266,
 354

 performance, 401

 stability margin, 166, 205, 241,
 387

Y

YJBK parametrization 14, 579

Z

Zero Exclusion Principle 38

