

On data-dependence of exponential stability and stability radii for linear time-varying differential-algebraic systems

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Abstract: This paper is addressed to some questions concerning the exponential stability and its robustness measure for linear time-varying differential-algebraic systems of index 1. First, the Bohl exponent theory that is well known for ordinary differential equations is extended to differential-algebraic equations. Then, it is investigated that how the Bohl exponent and the stability radii with respect to dynamic perturbations for a differential-algebraic system depend on the system data. The paper can be considered as a continued and complementary part to a recent paper on stability radii for time-varying differential-algebraic equations [N.H. Du, V.H. Linh, Stability radii for linear time-varying differential-algebraic equations with respect to dynamic perturbations, *J. Differential Equations* 230 (2006) 579-599]. © 2008 Elsevier Inc. All rights reserved.

Author Keywords: Bohl exponent; Data-dependence; Differential-algebraic equations; Exponential stability; Stability radii

Year: 2008

Source title: *Journal of Differential Equations*

Volume: 245

Issue: 8

Page : 2078-2102

Cited by: 1

Link: [Scopus Link](#)

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ISSN: 220396

CODEN: JDEQA

DOI: 10.1016/j.jde.2008.07.016

Language of Original Document: English

Abbreviated Source Title: *Journal of Differential Equations*

Document Type: Article

Source: Scopus

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References:

- Ascher, U.M., Petzold, L.R., Stability of computation for constrained dynamical systems (1993) *SIAM J. Sci. Statist. Comput.*, 14, pp. 95-120
- Balla, K., März, R., Linear differential algebraic equations of index 1 and their adjoint equations (2000) *Results Math.*, 37 (1-2), pp. 13-35
- Beckner, W., Inequalities in Fourier analysis (1975) *Ann. of Math. (2)*, 102 (1), pp. 159-182
- M. Bracke, On stability radii of parametrized linear differential-algebraic systems, PhD thesis, University of Kaiserslautern, 2000
- Brenan, K.E., Campbell, S.L., Petzold, L.R., (1996) *Numerical Solution of Initial Value Problems in Differential Algebraic Equations*, , SIAM, Philadelphia
- Byers, R., Nichols, N., On the stability radius of a generalized state-space system (1993) *Linear Algebra Appl.*, 188-189, pp. 113-134
- Cong, N.D., Nam, H., Lyapunov inequality for differential-algebraic equations (2003) *Acta Math. Vietnam.*, 28 (1), pp. 73-88
- Cong, N.D., Nam, H., Lyapunov's regularity for linear differential-algebraic equations of index-1 (2004) *Acta Math. Vietnam.*, 29 (1), pp. 1-21
- Daleckii, J.L., Krein, M.G., (1974) *Stability of Solutions of Differential Equations in Banach Spaces*, , Amer. Math. Soc., Providence, RI
- Du, N.H., Stability radii for differential-algebraic equations (1999) *Vietnam J. Math.*, 27, pp. 379-382
- Du, N.H., Linh, V.H., Robust stability of implicit linear systems containing a small parameter in the leading term (2006) *IMA J. Math. Control Inform.*, 23, pp. 67-84
- Du, N.H., Linh, V.H., Stability radii for linear time-varying differential-algebraic equations with respect to dynamic perturbation (2006) *J. Differential Equations*, 230, pp. 579-599
- Fridman, E., Stability of linear descriptor systems with delay: A Lyapunov-based approach (2002) *J. Math. Anal. Appl.*, 273, pp. 24-44
- Griepentrog, E., März, R., (1986) *Differential-Algebraic Equations and Their Numerical Treatment*, , Teubner-Texte zur Mathematik, Leipzig
- Higuera, I., März, R., Tischendorf, C., Stability preserving integration of index-1 DAEs (2003) *Appl. Numer. Math.*, 45, pp. 175-200
- Hinrichsen, D., Ilchmann, A., Pritchard, A.J., Robustness of stability of time-varying linear systems (1989) *J. Differential Equations*, 82, pp. 219-250
- Hinrichsen, D., Pritchard, A.J., Stability radius for structured perturbations and the algebraic Riccati equation (1986) *Systems Control Lett.*, 8, pp. 105-113
- Hinrichsen, D., Pritchard, A.J., A note on some difference between real and complex stability radii (1990) *Systems Control Lett.*, 14, pp. 401-408
- Hinrichsen, D., Pritchard, A.J., Destabilization by output feedback (1992) *Differential Integral Equations*, 5 (2), pp. 357-386
- Ilchmann, A., Mareels, I.M.Y., On stability radii of slowly time-varying systems (2001) *Advances in Mathematical System Theory*, pp. 55-75. , Birkhäuser, Boston
- Jacob, B., A formula for the stability radius of time-varying systems (1998) *J. Differential Equations*, 142, pp. 167-187
- Kunkel, P., Mehrmann, V., (2006) *Differential-Algebraic Equations. Analysis and Numerical Solution*, , EMS Publishing House, Zürich, Switzerland
- Kunkel, P., Mehrmann, V., Stability properties of differential-algebraic equations and spin-stabilized discretization (2007) *Electron. Trans. Numer. Anal.*, 26, pp. 385-420
- Lamour, R., März, R., Winkler, R., How Floquet theory applies to differential-algebraic equations (1998) *J. Math. Anal. Appl.*,

217, pp. 372-394

- V.H. Linh, V. Mehrmann, Spectral intervals for differential algebraic equations and their numerical approximations, preprint 402, DFG Research Center Matheon, TU Berlin, Berlin, Germany, 2007, url: [http://www.matheon.de/März, R., Numerical methods for differential-algebraic equations \(1992\) Acta Numer., pp. 141-198](http://www.matheon.de/März, R., Numerical methods for differential-algebraic equations (1992) Acta Numer., pp. 141-198)
- März, R., Practical Lyapunov stability criteria for differential algebraic equations (1994) Banach Center Publ., 29, pp. 245-266
- März, R., Criteria for the trivial solution of differential algebraic equations with small nonlinearities to be asymptotically stable (1998) J. Math. Anal. Appl., 225, pp. 587-607
- Qiu, L., Benhardson, B., Rantzer, A., Davison, E.J., Young, P.M., Doyle, J.C., A formula for computation of the real stability radius (1995) Automatica, 31, pp. 879-890
- Qiu, L., Davison, E.J., The stability robustness of generalized eigenvalues (1992) IEEE Trans. Automat. Control, 37, pp. 886-891
- Stykel, T., On criteria for asymptotic stability of differential-algebraic equations (2002) Z. Angew. Math. Mech., 92, pp. 147-158
- Tischendorf, C., On stability of solutions of autonomous index-1 tractable and quasilinear index-2 tractable DAE's (1994) Circuits Systems Signal Process., 13, pp. 139-154
- Wirth, F., Hinrichsen, D., On stability radii of infinite-dimensional time-varying discrete-time systems (1994) IMA J. Math. Control Inform., 11 (3), pp. 253-276
- Xu, S., Van Dooren, P., Radu, S., Lam, J., Robust stability and stabilization for singular systems with state delay and parameter uncertainty (2002) IEEE Trans. Automat. Control, 47, pp. 1122-1128
- Zhu, W., Petzold, L., Asymptotic stability of linear delay differential algebraic equations and numerical methods (1997) Appl. Numer. Math., 24, pp. 247-264
- Zhu, W., Petzold, L., Asymptotic stability of Hessenberg delay differential-algebraic equations of retarded or neutral type (1998) Appl. Numer. Math., 27, pp. 309-325