

IMPULSIVE INEQUALITIES FOR MULTI-DELAY JUMP CONDITIONS

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Abstract. In this paper, we establish some new impulsive inequalities for multi-delay jump conditions in which the jump conditions depend on multi-point of the states at past times. These inequalities can be used as basic tools in the study of differential equations with nonlocal impulse effects. Some examples are given to illustrate the application of our results.

Keywords. Impulsive Differential Inequality; Impulsive Integral Inequality; Jump Condition

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References

- [1] B.G. Pachpatte, Inequalities for differential and integral equations, Academic Press, London, 1998.
- [2] R.P. Agarwal, Y.H. Kim, S.K. Sen, New retarded integral inequalities with applications, *J. Inequal. Appl.*, ID **908784**, (2008) 15 pages.
- [3] C.J. Chen, W.S. Cheung, D. Zhao, Gronwall-Bellman-type integral inequalities and applications to BVPs, *J. Inequal. Appl.*, ID **258569**, (2009) 15 pages.
- [4] R. Xu, F. Meng, C. Song, On some integral inequalities on time scales and their applications, *J. Inequal. Appl.*, ID **464976**, (2010) 13 pages.
- [5] H. Ögünmez, U.M. Özkan, Fractional quantum integral inequalities, *J. Inequal. Appl.*, ID **787939**, (2011) 7 pages.
- [6] B. Zheng, Q. Feng, Some new nonlinear integral inequalities and their applications in the qualitative analysis of differential equations, *J. Inequal. Appl.*, (2011), 2011:**20**.
- [7] V. Lakshmikantham, D.D. Bainov, P.S. Simeonov, Theory of Impulsive Differential Equations, World Scientific, Singapore, 1989.
- [8] D.D. Bainov, P.S. Simeonov, Impulsive Differential Equations: Periodic Solutions and Applications, Longman Scientific & Technical, Harlow, 1993.
- [9] D.D. Bainov, P.S. Simeonov, Impulsive Differential Equations: Asymptotic Properties of the Solutions, World Scientific, Singapore, 1995.
- [10] A.M. Samoilenko, N.A. Perestyuk, Impulsive Differential Equations, World Scientific, Singapore, 1995.
- [11] M. Benchohra, J. Henderson, S. Ntouyas, Impulsive Differential Equations and Inclusions, Hindawi publishing Corporation, New York, 2006.
- [12] E. M. Bonotto, L. P. Gimenes, M. Federson, Oscillation for a second-order neutral equation with impulses, *Appl. Math. Comput.*, **215**, (2009) 1-15.
- [13] B. T. Cui, M. Han, H. Yang, Some sufficient conditions for oscillation of impulsive delay hyperbolic systems with Robin boundary conditions, *J. Comput. Appl. Math.*, **180**, (2005) 365-375.
- [14] D. Franco, J. J. Nieto, First-order impulsive ordinary differential equations with anti-periodic and nonlinear boundary conditions, *Nonlinear Anal.*, **42**, (2000) 163-173.
- [15] D. Franco, J. J. Nieto, Maximum principles for periodic impulsive first order problems, *J. Comput. Appl. Math.*, **88**, (1998) 149-159.
- [16] X. Fu, L. Zhang, Forced oscillation for impulsive hyperbolic boundary value problems with delay, *Appl. Math. Comput.*, **158**, (2004) 761-780.
- [17] L.P. Gimenes, M. Federson, Oscillation by impulses for a second-order delay differential equation, *Comput. Math. Appl.*, **52**, (2006) 819-828.
- [18] Z. He, W. Ge, Oscillations of second-order nonlinear impulsive ordinary differential equations, *J. Comput. Appl. Math.*, **158**, (2003) 397-406.
- [19] Z. He, X. He, Monotone iterative technique for impulsive integro-differential equations with periodic boundary conditions, *Comput. Math. Appl.*, **48**, (2004) 73-84.
- [20] J. Jiao, L. Chen, L. Li, Asymptotic behavior of solutions of second-order nonlinear impulsive differential equations, *J. Math. Anal. Appl.*, **337**, (2008) 458-463.
- [21] J. Li, J. Shen, Periodic boundary value problems for delay differential equations with impulses, *J. Comput. Appl. Math.*, **193**, (2006) 563-573.
- [22] J. Li, J. Shen, Periodic boundary value problems for impulsive integro-differential equations of mixed type, *Appl. Math. Comput.*, **183**, (2006) 890-902.

- [23] H. Liu, Q. Li, Asymptotic behavior of second-order impulsive differential equations, *Electron. J. Diff. Equ.*, **33**, (2011) 1-7.
- [24] J. Luo, Oscillation of hyperbolic partial differential equations with impulses, *Appl. Math. Comput.*, **133**, (2002) 309-318.
- [25] J.J. Nieto, R. Rodríguez-López, New comparison results for impulsive integro-differential equations and applications, *J. Math. Anal. Appl.*, **328**, (2007) 1343-1368.
- [26] M. Peng, Oscillation criteria for second-order impulsive delay difference equations, *Appl. Math. Comput.*, **146**, (2003) 227-235.
- [27] J. Shen, New maximum principles for first-order impulsive boundary value problems, *Appl. Math. Lett.*, **16**, (2003) 105-112.
- [28] C. Zhang, W. Feng, J. Yang, M. Huang, Oscillations of second order impulses nonlinear FDE with forcing term, *Appl. Math. Comput.*, **198**, (2008) 271-279.
- [29] S. Deng, C. Prather, Generalization of an impulsive nonlinear singular Gronwall-Bihari inequality with delay, *J. Inequal. Pure Appl. Math.*, **9**(2) (2008), Art. 34.
- [30] J. Li, On some new impulsive integral inequalities, *J. Inequal. Appl.*, ID **312395**, (2008) 8 pages.
- [31] Y. Peng, Y. Kang, M. Yuan, R. Huang, L. Yang, Gronwall-type integral inequalities with impulses on time scales, *Adv. Diff. Equ.*, 2011:**26**, (2011).
- [32] N.E. Tatar, An impulsive nonlinear singular version of the Gronwall-Bihari inequality, *J. Inequal. Appl.*, ID **84561**, (2006) 12 pages.
- [33] H. Wang, C. Ding, A new nonlinear impulsive delay differential inequality and its applications, *J. Inequal. Appl.*, 2011:**11**, (2011).
- [34] P. Thiramanus, J. Tariboon, Impulsive differential and impulsive integral inequalities with integral jump conditions, *J. Inequal. Appl.*, 2012:**25**, (2012).

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