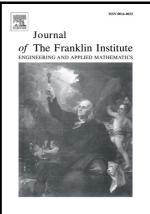
Author's Accepted Manuscript

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www.elsevier.com/locate/jfranklin

 PII:
 S0016-0032(15)30249-0

 DOI:
 http://dx.doi.org/10.1016/j.jfranklin.2016.11.036

 Reference:
 FI2825

To appear in: Journal of the Franklin Institute

Received date:18 August 2015Revised date:12 October 2016Accepted date:29 November 2016

Cite this article as: Cheng Gong, Xian Zhang and Ligang Wu, Multiple-integra inequalities to stability analysis of linear time-delay systems, *Journal of th Franklin Institute*, http://dx.doi.org/10.1016/j.jfranklin.2016.11.036

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Multiple-integral Inequalities to Stability Analysis of Linear Time-delay Systems $\stackrel{\bigstar}{\Rightarrow}$

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Abstract

This paper is concerned with the stability analysis of linear systems with constant delay. First, with the help of Schmidt orthogonalization, we define a new set of orthogonal polynomials. By using the orthogonal polynomial set, we propose a novel multiple-integral inequality, which can achieve less conservatism than many existing inequalities, such as the Jensen's single-integral inequality, the Jensen's double-integral inequality, the Wirtinger-based single-integral inequality and the auxiliary function-based double-integral inequality. Then, based on the proposed inequality, we derive a stability criterion for the system under consideration, which is less conservative than the existing ones. Finally, we provide a numerical example to illustrate the effectiveness of the derived criterion. *Keywords:* Linear time-delay system; Multiple-integral inequality; Stability; Orthogonal

polynomial; Schmidt orthogonalization.

1. Introduction

Time delay arises in a variety of dynamic systems, such as the systems of infectious diseases and epidemics [1], population dynamics [2], neural networks [3, 4], and biological and chemical kinetics [5]. It is generally regarded as a main cause of instability and poor performance [4, 6–8]. Therefore, the stability analysis of time-delay systems is very important and has received considerable attention [9–18]. In the field of stability analysis, Lyapunov functional method is one of the most popular methods [10, 15, 19–24]. Let us consider a linear time-delay system of the form:

$$\dot{x}(t) = Ax(t) + A_h x(t-h), \ t \ge 0,$$
(1.1a)

^{\approx}This work was supported in part by the National Natural Science Foundation of China (61203005, 11371006, 61525303), the Natural Science Foundation of Heilongjiang Province (QC2013C068, F201326 and A201416), the Fund of Heilongjiang Education Committee (12541603), and the Postdoctoral Science-research Developmental Foundation of Heilongjiang Province (LBH-Q12130).

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