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OPTIMAL ZERO LOCATIONS OF CONTINUOUS–TIME SYSTEMS WITH DISTINCT POLES TRACKING REFERENCE STEP RESPONSES

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Abstract. The problem of optimal zero locations of continuous–time systems with distinct poles tracking reference step responses, is considered in this paper. The step response deviation from the given reference step response is minimized, resulting in an explicit and easily computable solution for the transfer function numerator coefficients.
Keywords. Optimal zeros, tracking, linear continuous–time systems.

1 Introduction

Transfer function responses are of much interest in the area of circuits and systems as well as in the area of control systems. It is well known, that the transfer function responses are strongly affected, not only by the eigenvalues or poles, but the numerator coefficients, or equivalently, the system's zeros, as well. However, the lack of closed–form expressions of transfer function responses, long impeded the generalization of results obtained for low–order transfer functions.

Much interest has been shown in the general shaping of system responses, as evident, e.g., in the extrema–free problem and closely related problems, such as the non–overshooting problem. Necessary and sufficient conditions which guarantee that linear state–space models will not exhibit overshoot were presented in [1]. The influence of zero locations on the number of extrema in the step response of systems possessing real poles and real zeros was discussed in [2], where lower and upper bounds on the number of extrema are given. The influence of zero locations on undershoot was reported in [3]. The necessary and sufficient conditions for a third–order transfer function such that the non–overshooting and the monotone nondecreasing step responses are ensured, were presented in [4]. While most of these results lend themselves to analysis as opposed to synthesis, sufficient conditions that can be used for the synthesis of compensators for realizing non–overshooting and monotonically increasing responses for minimum phase SISO systems were presented in [5].