EE 752, Model Order Reduction : Assignment 1.

Submit by 18^{th} Feb 2015.

Q-1 Consider $G(s) = \dfrac{1}{(s+1)(s+5)}$

Obtain lower order ($k=1$) approximation by

(a) dominant pole method

(b) balanced truncation (of Hankel singular values)

(c) Arnoldi method (Markov parameter matching)

(d) Find H_2 norm & H_∞ norm of the error system $G-\hat{G}$ for each case.

(e) Plot on Scilab the Bode magnitude plots & the step responses (one plot for Bode magnitude plots; one for step responses) four curves per figure.

(f) Calculate Hankel singular values of $G(s)$

Q-2 (a) Suggest a matrix A for which the numerical range is not equal to the convex hull of all eigenvalues.

(b) For that matrix, construct the vector $x \in \mathbb{C}^n$ for which the two sets are unequal.

Q-3 Assume G has real distinct poles (& stable).

Show that $\|G(s)\|_{H_2} = \sum_{i=1}^{n} c_i G(-\lambda_i)$ and also

$$\|G(s)\|^2_{H_2} = \operatorname{trace} B^T Q B = \operatorname{trace} C P C^T$$

Q-4 : Consider $G(s) = \dfrac{1}{s+5}$. Calculate the H_∞ norm of G by definition $\left(:= \sup_{\omega} |G(j\omega)| \right)$

(b) as minimum γ for which ARE has a solution.

$\gamma \equiv$ gamma

(c) as minimum γ such that the Hamiltonian matrix $H(\gamma) := \begin{bmatrix} A^T K + KA + C^T C & KB \\ B^T K & -\gamma^{-2} \end{bmatrix}$ has no $j\mathbb{R}$ eigenvalues.

(Note: Discussion is allowed but no copying. Show only brief calculations.)