332:505 Control Theory I PROJECT

System Model Order Reduction Via Balancing Transformation

20% of the course grade. Project is due April 25, 2007

Part 1 (10 points)
Consider a linearized model of a fusion "tokamak" reactor derived in [1]. This system has one input (ΔS -the rate of injection of fuel density per cm^3/s and two outputs (Δn - plasma density per cm^3 and ΔT -kinetic temperature in keV. The transfer function from ΔS to Δn is given by

$$\frac{\Delta n}{\Delta S} = \frac{s + 0.258}{s^2 + 0.4906s + 0.0855}$$

(a) Use MATLAB to balance this system and find its Hankel singular values.
(b) Find the first-order reduced system based on the results obtained in (a).
(c) Using MATLAB, plot the *step* responses of the original and reduced systems.
(d) Using MATLAB, plot the *magnitude spectra* of the original and reduced systems.
(e) Using MATLAB, plot the *impulse* responses of the original and reduced systems.
(f) Comment on results obtained.

Part 2 (10 points)
Take an asymptotically stable system of your interest whose order is at least three (preferable a real physical system) and repeat steps (a)-(f) from part 1.

HINT: For Part 1 follow the class notes and use the corresponding MATLAB functions.

[1] D. A. Plummer, "Fusion reactor Control," *Proc. 16th IEEE/NPSS Symposium on Fusion Engineering*, pp. 1186-1189, 1995.