University of Wisconsin - Madison
Department of Electrical and Computer Engineering

ECE334 - State Space Systems Analysis
Spring 2006

Problem Set 2

Distributed: Monday, 13 February, 2006
Due: Tuesday, 21 February, 2006

Problem 1

As discussed in class, the (nonlinear) state space model of the tunnel diode circuit is given by,

$$\dot{x}_1 = 0.5(-h(x_1) + x_2) \tag{1}$$
$$\dot{x}_2 = 0.2(-x_1 - 1.5x_2 + 1.2) \tag{2}$$

where

$$h(x) = 17.76x - 103.79x^2 + 229.62x^3 - 226.31x^4 + 83.72x^5. \tag{3}$$

In the class notes, the three equilibrium points were given as (0.063,0.758), (0.285,0.61) and (0.884,0.21). Determine the equilibria accurate to four decimal places.

Problem 2

Derive the (approximate) linear models obtained by linearizing the nonlinear model (1)-(3) around each of the three equilibria. (Note: You should obtain three different linear models.)

Problem 3

Consider the linear model corresponding to equilibrium point $(x_1^*, x_2^*) = (0.884, 0.21)$. Show the phase portrait for this model for various initial conditions chosen from $x_1 \in [x_1^* - 0.1, x_1^* + 0.1]$ and $x_2 \in [x_2^* - 0.1, x_2^* + 0.1]$. Compare the behaviour given by the approximate linear model with that given by the true nonlinear model.

Repeat the above comparison with initial conditions chosen from $x_1 \in [x_1^* - 0.01, x_1^* + 0.01]$ and $x_2 \in [x_2^* - 0.01, x_2^* + 0.01]$.

Discuss the accuracy of the approximate model for these two comparison cases.

Problem 4

Bay, problem 2.7.