EEC 643/743/ESC794: Homework 4

Due on Mar. 18, 2019

Please include all the equation development, Matlab codes, Simulink model, and simulation results in your homework. Please have a cover page with "Homework 1" title and your printed name. The problems should be in order and all the pages should be stapled together. Any deviation from the required format will result in a deduction from the homework grade. The homework has to be completed independently and individually. Identical submissions will result in grades of ZERO.

1. Please draw the phase portraits of the following Van der Pol system using Matlab. Observe the change of the limit cycle as α is varying. Please choose α as 0, 1, 2, and 4 respectively, and plot four phase portraits accordingly. Make your own conclusions.

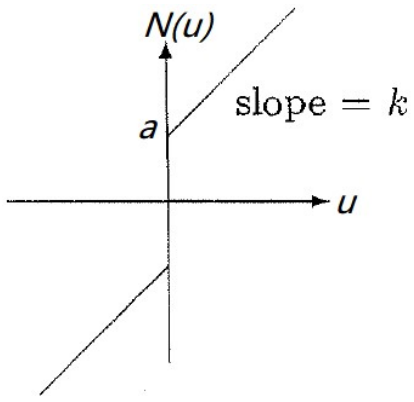
$$\ddot{\mathrm{x}} + \alpha(\mathrm{x}^2 - 1)\dot{\mathrm{x}} + \mathrm{x} = 0$$

2. Please use the Corollary of La Salle's Invariant Set Theorem to prove the asymptotic stability of the following nonlinear system around origin point.

$$\dot{x}_1 = x_2$$
$$\dot{x}_2 = -x_1^2 + x_2^3 - x_1 - x_2$$

You may choose $V(X) = \frac{1}{2}x_2^2 + \int_0^{x_1}(y^2 + y)dy$, where $(y^2 + y)y > 0$.

3. Please find the describing function *N(u)* of a nonlinear system where the input $u=Asin(\omega t)$, and the nonlinearity is illustrated by the following figure.



4. (For EEC743 and ESC794 students only) A nonlinear function is illustrated in the following figure. A sinusoidal input (u) to this nonlinearity is represented by $u=Asin(\omega t)$. Please find the describing functions $N(u)$ as A is larger or smaller than a respectively.