Department of Electrical Engineering
EEL702, Nonlinear system,
Minor Test I, 2016-2017/I.
Max. time: 1 hour, Max. marks: 20.

Marks: Q1: 7, Q2: 7, Q3: 6

- **Write clearly each step of your calculation.**

Q1.(a)State and explain the assumptions which are necessary to define describe function.
(b) Suppose the input output behavior of a nonlinear element is shown in the figure 1a.
Find the describing function N?
(c) Consider the following block diagram where $G(s)= 1/s(s+1)^2$ and the nonlinear element is same as in part (b). Find the frequency and amplitude of the oscillation of limit cycle.

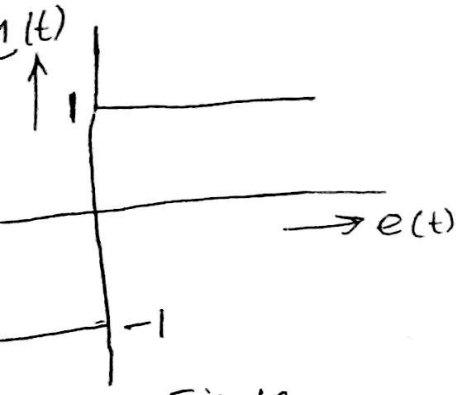
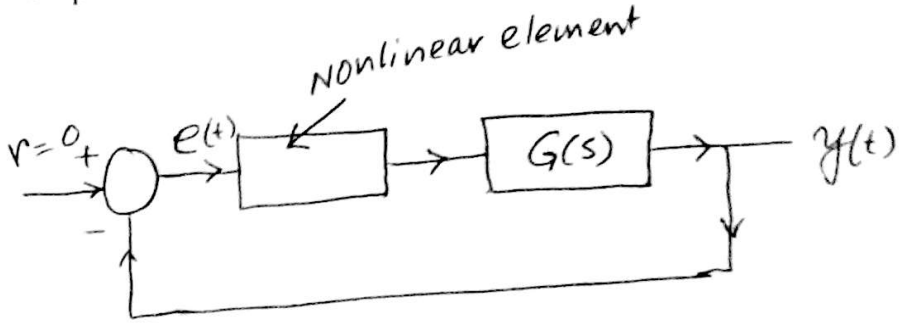


Fig. 1a.



Q2.(a) Suppose $h(x) = \dfrac{x^T x}{x^T P x}$ where $x \in R^3$ and P =**diag** ([3 4 2]), a diagonal matrix. Find the minimum value of $h(x)$? (Derive the intermediate steps.)

(b) Suppose $A = \begin{bmatrix} -4 & 1 & 1 \\ 2 & 0 & -2 \\ 1 & -3 & -6 \end{bmatrix}$. Find the matrix 1-norm $\|A\|_1$ and matrix 1- measure $\mu_1(A)$?

3. Find all equilibrium points of the system

$$\dot{x}_1 = a x_1 - x_1 x_2$$
$$\dot{x}_2 = b x_1^2 - c x_2$$

for all positive real values of a, b, and c, and determine the type of each equilibrium.