Department of Electrical Engineering
EEL702, Nonlinear system,
Minor Test I, 2018-2019/I.
Max. time: 1 hour, Max. marks: 15.

Marks: Q1: 5, Q2: 4, Q3: 6

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

Q1.(a) Figure-1 shows a nonlinear element and a system where $G(s) = 1/s(s+1)^2$ Find the frequency and amplitude of the oscillation of limit cycle.

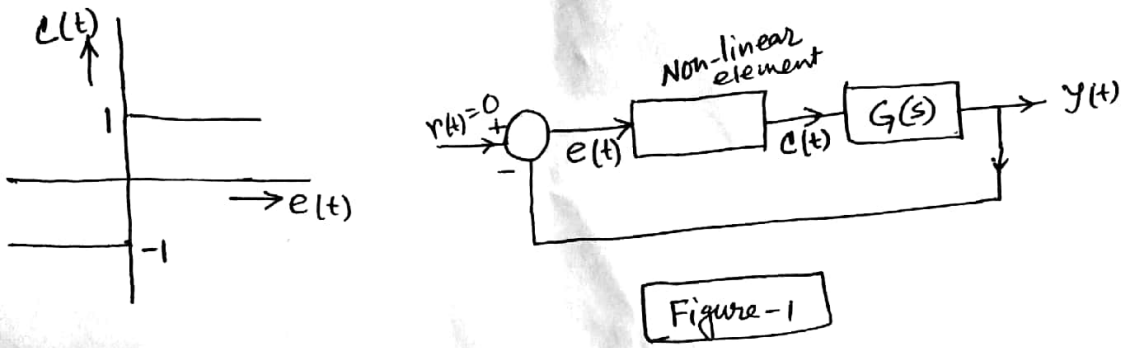


Figure-1

Q2.(a) Suppose $h(x) = \frac{x^T x}{x^T P x}$ 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.)

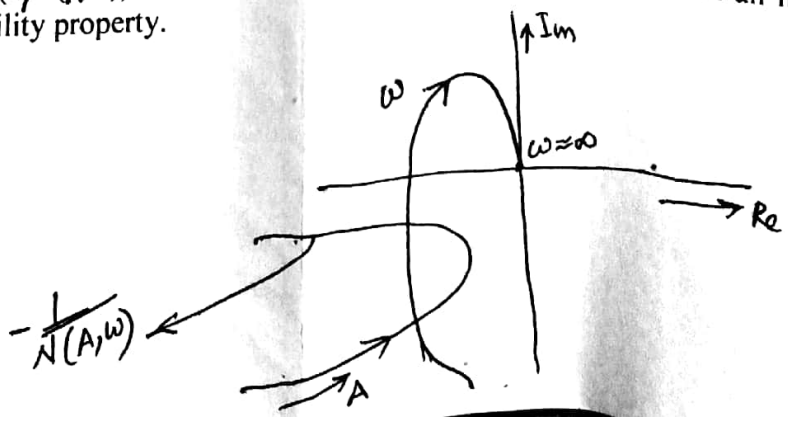
(b) Suppose $A = \begin{bmatrix} -4 & 1 & 1 \\ 2 & 0 & -2 \\ 1 & -3 & -6 \end{bmatrix}$. Find the matrix 1-norm $\|A\|_1$ and matrix infinity norm $\|A\|_\infty$?

3. (a) 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. Also draw the phase-portrait corresponding to saddle point (if any).

(b) The polar plot of open-loop transfer function G(s)H(s) and the inverse plot of describing function ($-1/N(A,w)$) are shown in Figure-2. Explain the existence of all limit cycles and their stability property.



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