GATE ASSIGNMENT 4

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Download all python codes from

https://github.com/AmulyaTallamraju/EE3900/blob/main/GATE_Assignment-4/codes/GATE_Assignment-4.py

and latex-tikz codes from

https://github.com/AmulyaTallamraju/EE3900/blob/main/GATE_Assignment-4/GATE_Assignment-4.tex

1 GATE EC 2000 Q.1.13

A system with an input $x(t)$, and output $y(t)$ is described by the relation $y(t) = tx(t)$. The system is

1) linear and time-invariant
2) linear and time varying
3) non-linear and time-invariant
4) non-linear and time-varying

2 Solution

Let $x_1(t)$ and $x_2(t)$ be two signals such that

$$y_1(t) = tx_1(t) \tag{2.0.1}$$
$$y_2(t) = tx_2(t) \tag{2.0.2}$$

Let

$$x(t) = \alpha x_1(t) + \beta x_2(t) \tag{2.0.3}$$
$$y(t) = tx(t) \tag{2.0.4}$$
$$= t(\alpha x_1(t) + \beta x_2(t)) \tag{2.0.5}$$
$$= \alpha y_1(t) + \beta y_2(t) \tag{2.0.6}$$

Thus, the system is linear. Let there be a delay of δ in the input signal

$$x_d(t) = x(t + \delta) \tag{2.0.7}$$
$$y(t) = tx(t) \tag{2.0.8}$$
$$y_1(t) = tx_d(t) \tag{2.0.9}$$
$$= tx(t + \delta) \tag{2.0.10}$$

Now delay the output by δ

$$y(t) = tx(t) \tag{2.0.11}$$
$$y_2(t) = y(t + \delta) \tag{2.0.12}$$
$$= (t + \delta)x(t + \delta) \tag{2.0.13}$$

Clearly $y_1(t) \neq y_2(t)$, therefore the system is not time-invariant

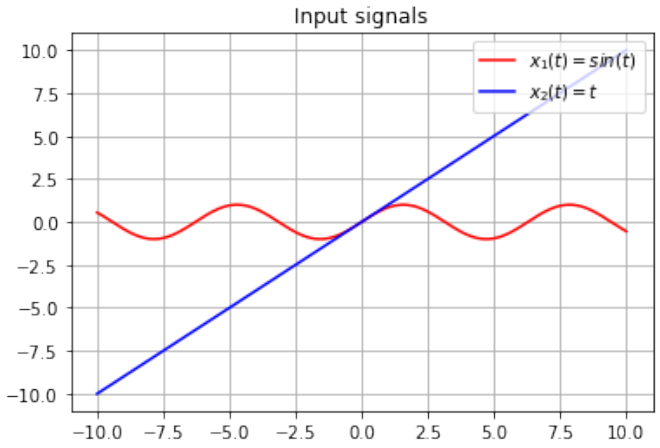

Fig. 4: $x_1(t) = \sin t$ and $x_2(t) = t$

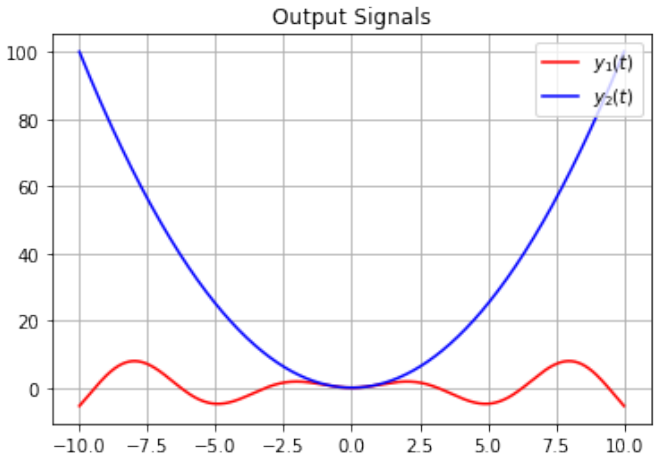

Fig. 4: $y_1(t)$ and $y_2(t)$

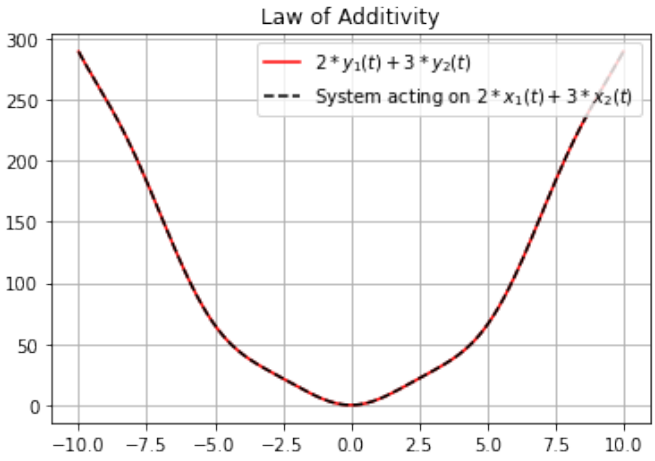

Fig. 4: Linearity

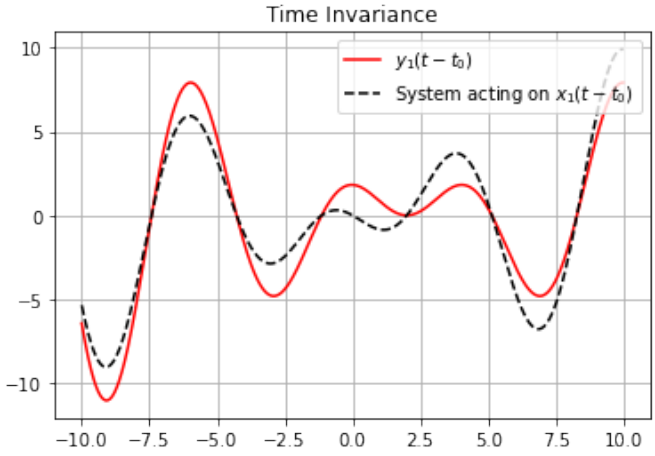

Fig. 4: Time invariance