Control Systems

Assignment 1

Chirag Jain
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Question

Q49. A system's output, c, is related to the system's input, r, by the straight-line relationship, $c = 5r + 7$. Is the system linear?

Solution

- We know that a linear system has two properties **superposition** and **homogeneity**.
- Checking for superposition:
  - For an input r_1 , the system's output is $c_1 = 5r_1 + 7$.
  - For an input r_2 , the system's output is $c_2 = 5r_2 + 7$.
  - For an input $r_1 + r_2$, the system's output is $5(r_1 + r_2) + 7$.
- As per the property of superposition, if an input of r_1 yields an output of c_1 and an input of r_2 yields an output of c_2, then an input of $r_1 + r_2$ yields an output of $c_1 + c_2$.
- We can observe that, $c_1 + c_2 = 5(r_1 + r_2) + 14$, which is not equal to the input $(r_1 + r_2)$.
- Hence we see that the given system does not follow principle of superposition.

Solution

- Checking for homogeneity:
  - For an input r_1 , the system's output is $c_1 = 5r_1 + 7$.
  - For an input Ar_1 , the system's output is $c_1 = 5Ar_1 + 7$.
- As per the property of homogeneity, if for an input of r_1 that yields an output of c_1, an input of Ar_1 yields an output of Ac_1.
- We can observe that, for the input Ar_1, the output $(5Ar_1 + 7)$ is not equal to Ac_1 which is $[A(5r_1 + 7)]$.
- Hence we see that the given system does not follow principle of homogeneity.
- Thus we can say that the given system is **not Linear**.