# CONTROL SYSTEM

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# Q 9

Given, a transfer function is $\frac{s^5+2s^4+4s^3+s^2+4}{s^6+7s^5+3s^4+2s^3+s^2+5}$ and asked to find it's differential equation.

$$\frac{C(s)}{R(s)} = \frac{s^5 + 2s^4 + 4s^3 + s^2 + 4}{s^6 + 7s^5 + 3s^4 + 2s^3 + s^2 + 5} \tag{0.1}$$

i.e,

$$(\mathrm{s}^6 + 7s^5 + 3s^4 + 2s^3 + s^2 + 5)C(s) = (s^5 + 2s^4 + 4s^3 + s^2 + 4)R(s)$$

As

$$L^{-1}(s^n G(s)) = \frac{d^n g(t)}{dt} \tag{0.2}$$

with Zeroing all the initial conditions.
$\implies (s^6 + 7s^5 + 3s^4 + 2s^3 + s^2 + 5)C(s) = (s^5 + 2s^4 + 4s^3 + s^2 + 4)R(s)$

Now, take an inverse laplace transform on both sides,

$\implies \frac{d^6 c(t)}{dt} + 7\frac{d^5 c(t)}{dt} + 3\frac{d^4 c(t)}{dt} + 2\frac{d^3 c(t)}{dt} + \frac{d^2 c(t)}{dt} + 5c(t) =$
$\frac{d^5 r(t)}{dt} 2\frac{d^4 r(t)}{dt} + 4\frac{d^4 r(t)}{dt} + \frac{d^2 r(t)}{dt} + 4r(t)$

therefore the differential equation of this system is

$$\mathrm{c(t)}^{''''''} + 7c(t)^{'''''} + 3c(t)^{''''} + 2c(t)^{'''} + c(t)^{''} + 5c(t) = r(t)^{'''''} + 2r(t)^{''''} + 4r(t)^{'''} + r(t)^{''} + 4r(t)$$