

Z-transform using MATLAB

?

We need to know:-

- (1) creating TF & its frequency response.
- (2) Applying signal To LTI in Z-domain.
- (3) Evaluating Impulse response from TF.
- (4) stability of TF.
- (5) Inverse of Z-transform

(I) creating TF:-

MATLAB works with TF

$$H(z) = \frac{B(z)}{A(z)}$$

numerator
written as vector.

den.
written as vector.

note: the vectors contain the coff's of $B(z)$ & $A(z)$
in descending powers of -ve z

ex.

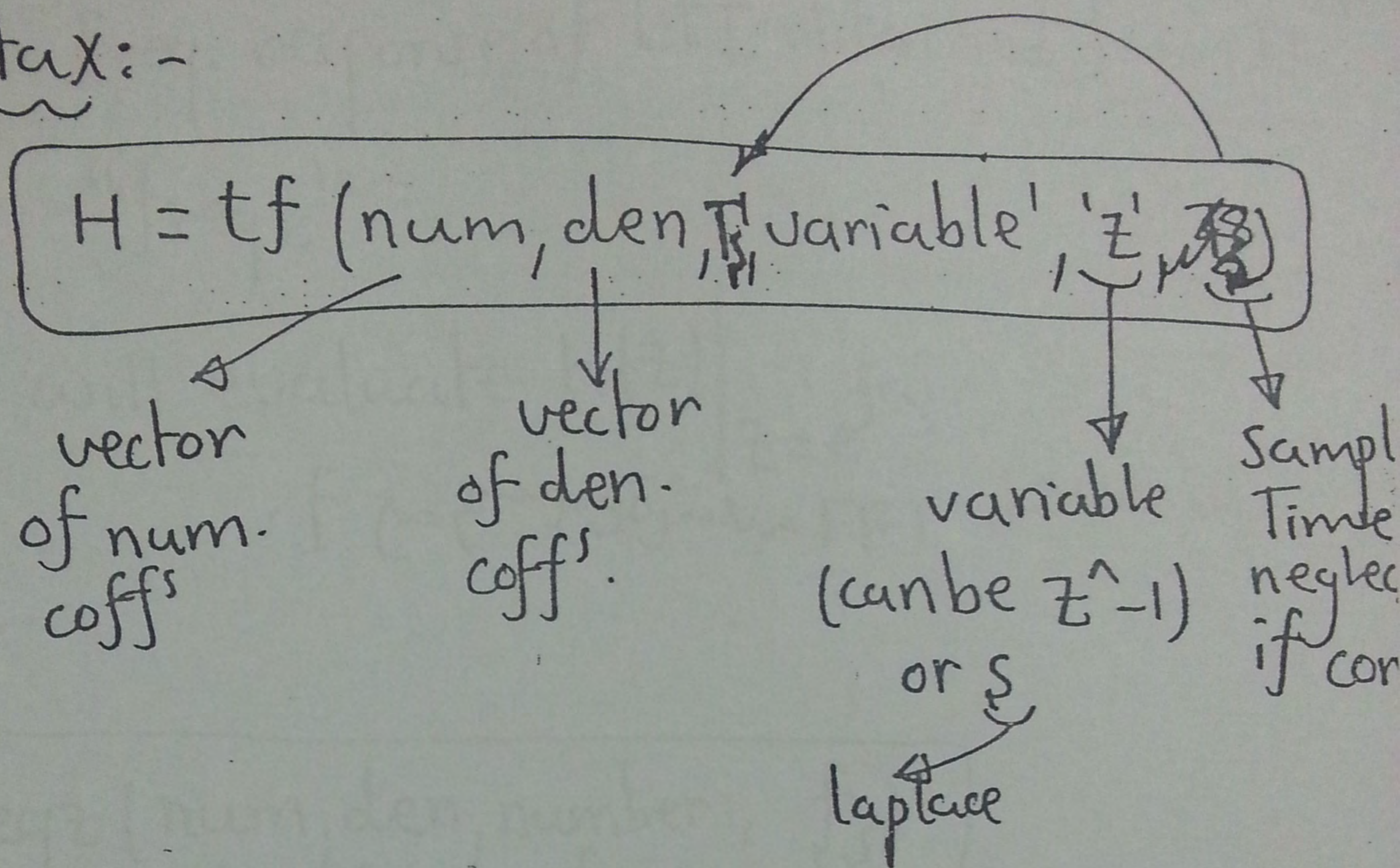
$$H(z) = \frac{z^2}{z^2 + 2z + 3}$$

$$= \frac{1}{1 + 2z^{-1} + 3z^{-2}}$$

$$\therefore \text{num} = [1] \quad \text{den} = [1 \ 2 \ 3]$$

TF:-

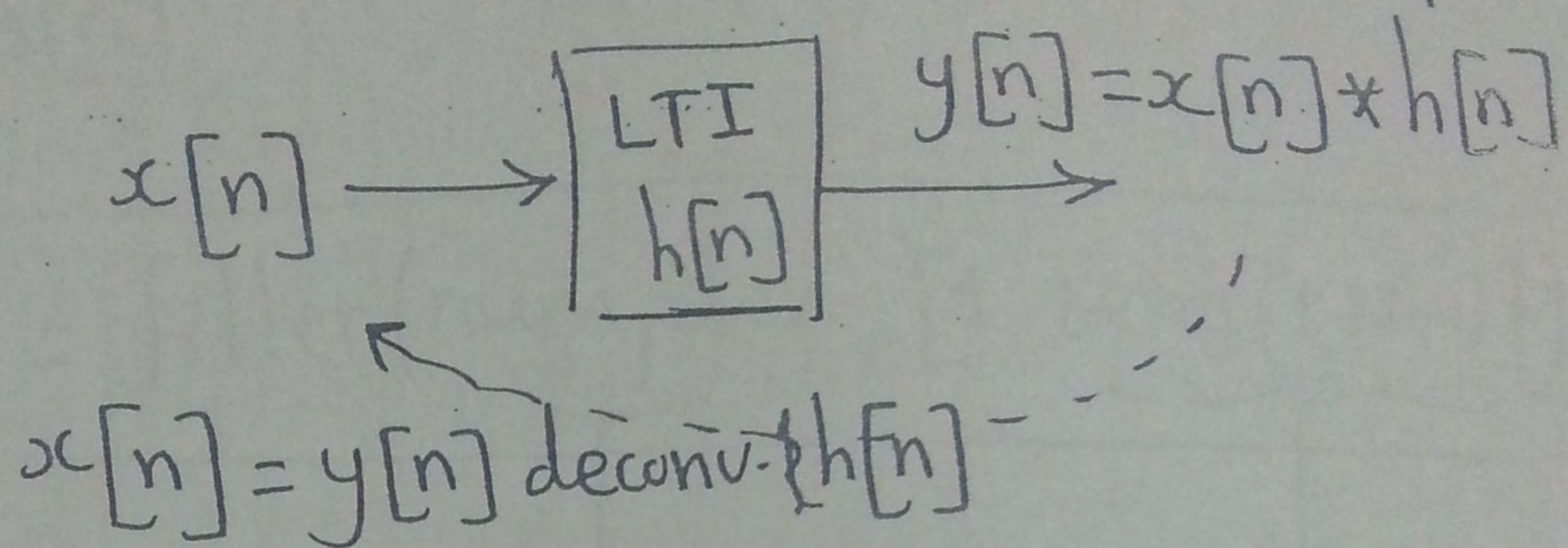
Syntax:-



ex.

Generate TF in ex.(1) with $T_s = 0.1$

deconvolution: the inverse of convolution process



deconvolution in MATLAB do a polynomial division in z -domain

$$\therefore x[n] = z^{-1} \left\{ \frac{Y(z)}{H(z)} \right\}$$

ex.

$$x = [1 \ 2 \ 3 \ 4]$$

$$h = [4 \ 3 \ 2 \ 1]$$

$$\therefore y = \text{conv}(x, h);$$

$$x = \text{deconv}(y, h)$$

Obtaining Impulse response from TF: -

Impulse response $h[n] \triangleq$ o/p of system when i/p signal is $\delta[n]$

$$\therefore h = \text{filter}(\text{num}, \text{den}, [1 \text{ zeros}(1, N-1)])$$

Impulse response of N points

TF

$\delta[n]$ of N points

Also, step response.

$$S = \text{filter}(\text{num}, \text{den}, \text{ones}(1, N));$$

ex-

Find Impulse response of system shown, Is it stable?

IV) STABILITY of $H(z)$:-

To discuss stability of $H(z)$, we must calculate poles & zeros

zplane
zero-pole plot

$$\text{zplane}([\text{num}], [\text{den}])$$

pzmap
calculate pole-zero
map of LTI systems

$$[p, z] = \text{pzmap}(\text{sys})$$

TF \rightarrow discrete-time
discrete-time

To identify stability

stable

All poles inside
unit circle

$$|P| < 1$$

$$\text{abs}(P) < 1$$

marginally
stable.

1 pole on unit
circle.

$$|P| = 1$$

$$\text{abs}(P) = 1$$

unstable.

$$|P| > 1$$

$$\text{abs}(P) > 1$$

NOTE:-

we can transform from poles & zeros to TF as

$$[b, a] = \text{zp2tf}(\text{zeros}, \text{poles}, \text{gain})$$

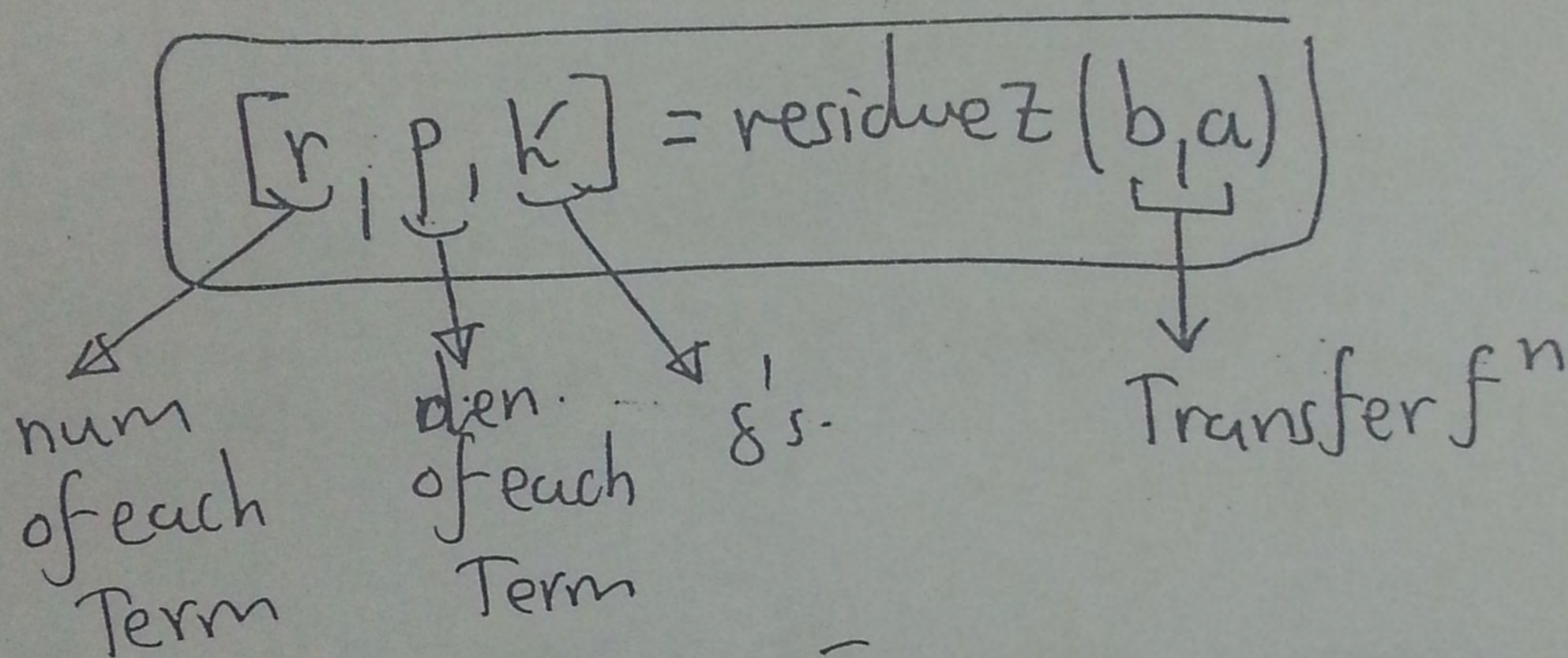
Inverse z-transform :-

→ using partial fraction expansion

$$H(z) = \frac{r(1)}{1-p(1)z^{-1}} + \dots + \frac{r(n)}{1-p(n)z^{-1}} + k(1) + k(2)z^{-1} + \dots$$

$$\therefore h[n] = r(1)(p(1))^n + r(2)(p(2))^n + \dots + k(1)\delta[n] + k(2)\delta[n-1]$$

Syntax :-



~~~~~~ بالجداول المتكافئة ~~~~~~

--  $[b, a] = \text{residuez}[r, p, k]$