Inverse Z-Transform :-

1) partial fraction Method
2) Power series expansion Method (or) Long Division Method

steps :-

1) convert $X(z)$ to the posible powers of z
2) Bring $X(z)$ to $X(z)/z$
3) Apply partial fraction Method
4) Multiply with z
5) Take Inverse z-transform based on ROC

1) Find Inverse z-transform of $X(z) = \frac{z+4}{z^2-4z+3}$

$$X(z) = \frac{z(z+4)}{z(z^2-4z+3)}$$

$$\frac{X(z)}{z} = \frac{z+4}{z(z-1)(z-3)}$$

$$\frac{z+4}{z(z-1)(z-3)} = \frac{A}{z} + \frac{B}{z-1} + \frac{C}{z-3}$$

$$z+4 = A(z-1)(z-3) + B(z)(z-3) + C(z)(z-1)$$

Put $z=1$: $5 = B(-2)$, $B = -5/2$

Put $z=0$: $4 = A(-1)-3$, $A = 4/3$

Put $z=3$: $7 = C(3)(2)$, $C = 7/6$

$$\frac{X(z)}{z} = \frac{4/3}{z} - \frac{5}{2(z-1)} + \frac{7}{6(z-3)}$$

$$X(z) = \frac{4z}{3z} - \frac{5z}{2(z-1)} + \frac{7z}{6(z-3)}$$

$$x(n) = 4/3\,\delta(n) - 5/2\,u(n) + 7/6\,(3)^n u(n)$$

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Find the Inverse z-transform of $X(z) = \frac{1}{(1+z^{-1})(1-z^{-1})^2}$

ROC : $|z| > 1$

$$X(z) = \frac{1}{(1+1/z)(1-1/z)^2}$$

Multiply & Divide by z^2

$$X(z) = \frac{z^2}{z^2} \frac{1}{(1+1/z)(1-1/z)^2}$$

$$X(z) = \frac{1}{\left(\frac{z+1}{z}\right)\frac{(z-1)^2}{z^2}} \cdot \frac{z^2}{z^2}$$

$$\frac{X(z)}{z} = \frac{z^2}{(z+1)(z-1)^2}$$

$$\frac{z^2}{(z+1)(z-1)^2} = \frac{A}{z+1} + \frac{B}{z-1} + \frac{C}{(z-1)^2}$$

$$z^2 = A(z-1)^2 + B(z+1)(z-1) + C(z+1)$$

put $z=1$

$1 = C(2)$

$\boxed{C = 1/2}$

put $z=-1$

$1 = A(4)$

$\boxed{A = 1/4}$

put $z=0$

$0 = 1/4 + B(-1) + 1/2$

$\boxed{B = 3/4}$

$$\frac{X(z)}{z} = \frac{1}{4(z+1)} + \frac{3}{4(z-1)} + \frac{1}{2(z-1)^2}$$

$$X(z) = \frac{z}{4(z+1)} + \frac{3z}{4(z-1)} + \frac{z}{2(z-1)^2}$$

$$x(n) = 1/4\ u(n) + 3/4\ u(n) + 1/2\ n\ u(n)$$

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