

NCERT Discrete 11.5.9 Q20

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Question: If a, b, c are in A.P.; b, c, d are in G.P and $\frac{1}{c}, \frac{1}{d}, \frac{1}{e}$ are in A.P. prove that a, c, e are in G.P.

Solution:

Symbol	Value	Description	Z-Transform
$x_1(n)$	$\{a, b, c, \dots\}$	A.P Sequence	$X_1(z)$
$x_2(n)$	$\{b, c, d, \dots\}$	G.P Sequence	$X_2(z)$
$x_3(n)$	$\{\frac{1}{c}, \frac{1}{d}, \frac{1}{e}, \dots\}$	A.P Sequence	$X_3(z)$
$y(n)$	$\{a, c, e, \dots\}$	Sequence	$Y(z)$

TABLE I
PARAMETERS

$$Y(z) = \frac{c}{1 - \frac{c}{a}z^{-1}}, \quad |z| > \left| \frac{y(1)}{y(0)} \right| \quad (12)$$

2) For $x_1(n)$:

$$x_1(n) = (b + n(b - a))u(n) \quad (13)$$

$$x_1(n) \xleftrightarrow{Z} X_1(z)$$

$$X_1(z) = \frac{a}{1 - z^{-1}} + \frac{(b - a)z^{-1}}{(1 - z^{-1})^2}, \quad |z| > 1 \quad (14)$$

3) For $x_2(n)$:

$$x_2(n) = b \left(\frac{c}{b} \right)^n u(n) \quad (15)$$

$$x_2(n) \xleftrightarrow{Z} X_2(z)$$

$$X_2(z) = \frac{c}{1 - \frac{c}{b}z^{-1}}, \quad |z| > \left| \frac{x_2(1)}{x_2(0)} \right| \quad (16)$$

4) For $x_3(n)$:

$$x_3(n) = \left(\frac{1}{c} + n \left(\frac{1}{c} - \frac{1}{d} \right) \right) u(n) \quad (17)$$

$$x_3(n) \xleftrightarrow{Z} X_3(z)$$

$$X_3(z) = \frac{\frac{1}{c}}{1 - z^{-1}} + \left(\frac{1}{d} - \frac{1}{c} \right) \frac{z^{-1}}{(1 - z^{-1})^2}, \quad |z| > 1 \quad (18)$$

$$b - a = c - b \quad (1)$$

$$2b = a + c \quad (2)$$

$$c^2 = b \times d \quad (3)$$

$$d = \frac{c^2}{b} \quad (4)$$

$$\frac{1}{d} - \frac{1}{c} = \frac{1}{e} - \frac{1}{d} \quad (5)$$

$$\frac{2}{d} = \frac{1}{c} + \frac{1}{e} \quad (6)$$

From (4),

$$\frac{2b}{c^2} = \frac{1}{c} + \frac{1}{e} \quad (7)$$

From (2),

$$\frac{a + c}{c^2} = \frac{1}{c} + \frac{1}{e} \quad (8)$$

$$\frac{a}{c^2} + \frac{1}{c} = \frac{1}{c} + \frac{1}{e} \quad (9)$$

$$a \times e = c^2 \quad (10)$$

So, a, c, e are in G.P

1) For $y(n)$:

$$y(n) = a \left(\frac{c}{a} \right)^n u(n) \quad (11)$$

$$y(n) \xleftrightarrow{Z} Y(z)$$