	Marwadi University **Faculty of Engineering & Technology** **Department of Information and Communication Technology**	
Subject: Programming With Python (01CT1309)	**Aim:** Analysis of Discrete-Time Signals Using Z-Transform	
Experiment No: 17	**Date:04-10-2025**	**Enrollment No:92400133131**

Aim: Analysis of Discrete-Time Signals Using Z-Transform

IDE:

Install Library

pip install sympy

Example 1:

```
import sympy as sp
# Define symbols
n, z, a = sp.symbols('n z a')
# Define the signal x[n] = a^n * u[n]
x_n = a**n
# Compute the Z-transform
X_z = sp.summation(x_n * z**(-n), (n, 0, sp.oo))
# Print the result
print("Z-transform of x[n] = a^n u[n]:")
sp.pprint(X_z, use_unicode=True)
```

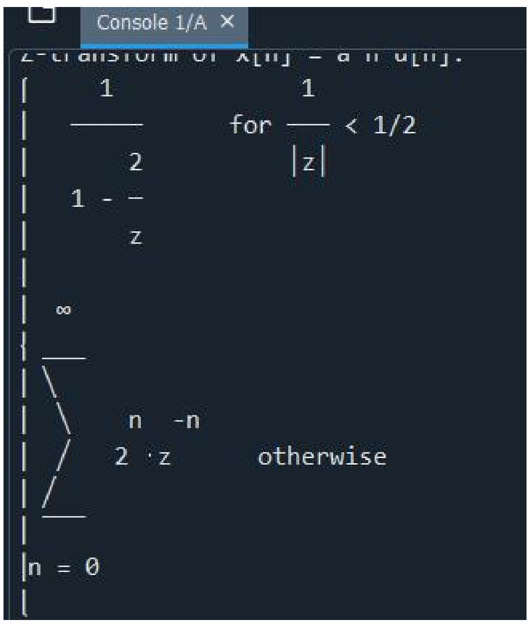
Output :-

```
In [2]: %runfile D:/paython/farhan.py --wdir
Z-transform of x[n] = a^n u[n]:
⎧     1            │a│
⎪  ───────     for │─│ < 1
⎪    a             │z│
⎪  - ─ + 1
⎪    z
⎪
⎪  ∞
⎨ ___
⎪ ╲
⎪  ╲    n  -n
⎪  ╱   a ⋅z      otherwise
⎪ ╱
⎪ ‾‾‾
⎪
⎩n = 0
```

Example 2:

```
# Define symbols
n, z, a = sp.symbols('n z a')
# Define the signal x[n] = a^n * u[n]
x_n = 2**n
# Compute the Z-transform
X_z = sp.summation(x_n * z**(-n), (n, 0, sp.oo))
# Print the result
print("Z-transform of x[n] = a^n u[n]:")
sp.pprint(X_z, use_unicode=True)
```

Output :-



Example 3:

```
import sympy as sp
# Define symbols
n, z = sp.symbols('n z')
```

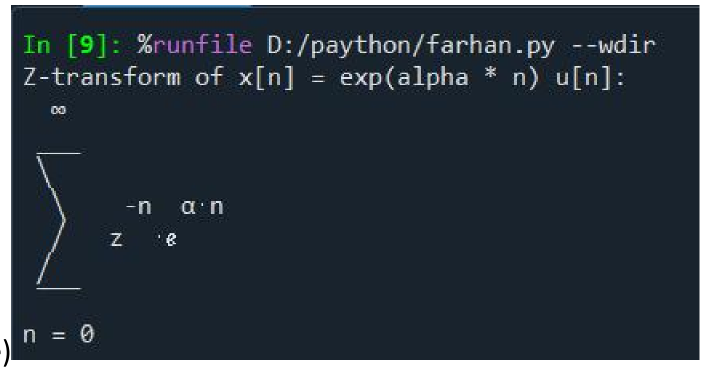
# Define the unit step signal u[n]
u_n = 1
# Compute the Z-transform
U_z = sp.summation(u_n * z**(-n), (n, 0, sp.oo))
# Print the result
print("Z-transform of the unit step signal u[n]:")
sp.pprint(U_z, use_unicode=True)

```
Z-transform of the unit step signal u[n]:
⎧   1          1
⎪ ─────    for ── < 1
⎪     1        │z│
⎪ 1 - ─
⎪     z
⎪
⎪  ∞
⎨ ___
⎪ ╲
⎪  ╲    -n
⎪  ╱   z     otherwise
⎪ ╱
⎪ ‾‾‾
⎪n = 0
⎩
```

Example 4:
import sympy as sp
# Define symbols
n, z, alpha = sp.symbols('n z alpha')
# Define the signal x[n] = exp(alpha * n) * u[n]
x_n = sp.exp(alpha * n)
# Compute the Z-transform
X_z = sp.summation(x_n * z**(-n), (n, 0, sp.oo))
# Print the result

print("Z-transform of x[n] = exp(alpha * n) u[n]:")

sp.pprint(X_z, use_unicode=True)



Example 5:

import sympy as sp

Define symbols

n, z = sp.symbols('n z')

Define the finite sequence x[n] = {1, 2, 3}

x_n = [1, 2, 3]

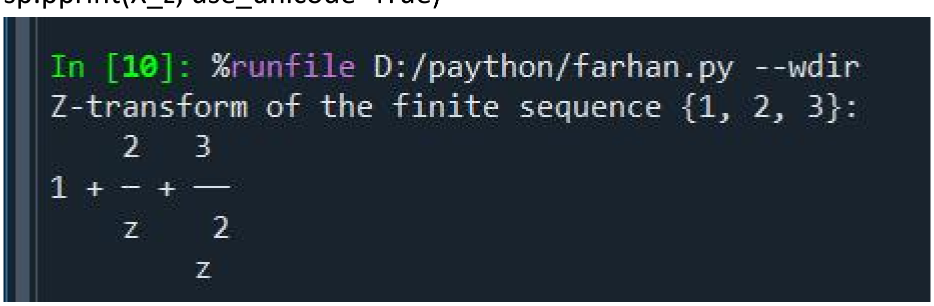
Compute the Z-transform manually

X_z = sum(x_n[i] * z**(-i) for i in range(len(x_n)))

Print the result

print("Z-transform of the finite sequence {1, 2, 3}:")

sp.pprint(X_z, use_unicode=True)



Example 6

import sympy as sp

Define symbols

n, z, omega = sp.symbols('n z omega')

Define the sinusoidal sequence x[n] = sin(omega * n) * u[n]

x_n = sp.sin(omega * n)

```
# Compute the Z-transform
X_z = sp.summation(x_n * z**(-n), (n, 0, sp.oo))
# Print the result
print("Z-transform of x[n] = sin(omega * n) u[n]:")
sp.pprint(X_z, use_unicode=True)
```

```
In [12]: %runfile D:/paython/farhan.py --wdir
Z-transform of x[n] = sin(omega * n) u[n]:
  ∞
 ___
 ╲
  ╲
   ╲     -n
   ╱   z   ⋅sin(n⋅ω)
  ╱
 ╱
 ‾‾‾
n = 0
```

Post Lab Exercise:

- Using Python, compute the Z-transform of the sequence $x[n] = 3^n u[n]$.

Output :-from sympy import symbols, Sum, oo, z

from sympy.functions.elementary.miscellaneous import Heaviside

n = symbols('n', integer=True)

a = 3

x_n = a**n * Heaviside(n)

X_z_sum = Sum(x_n * z**(-n), (n, 0, oo)).doit()

print(X_z_sum)

- Using Python, compute the Z-transform of the sequence $x[n] = \cos(wn)u[n]$.

Code :-from sympy import symbols, cos, summation, oo, exp, I

n, z, w = symbols('n z w', real=True)

x_n = cos(w * n)

X_z = summation(x_n * z**(-n), (n, 0, oo))

print(X_z.simplify())

```
In [17]: %runfile D:/paython/sympy.py --wdir
Sum(cos(n*w)/z**n, (n, 0, oo))

In [18]:
```