Signals and Systems Laboratory
Indian Institute of Technology Jammu
Experiment No.-9

Objective- (a) Design a discrete-time lowpass filter using impulse invariance.

Apparatus- Python+matplotlib.
Theory-
Suppose that we wish to obtain an ideal lowpass discrete-time filter with cutoff frequncy $\omega_c < \pi$. We can do this by sampling a continuous-time ideal lowapass filter with cutoff frequency $\Omega_c = \frac{\omega_c}{T} < \frac{\pi}{T}$ defined by

$$H_c(j\Omega) = \begin{cases} 1, & |\Omega| < \Omega_c \\ 0, & |\Omega| \leq \Omega_c \end{cases}$$

The impulse response of this continuous-time system is

$$h_c(t) = \frac{sin(\Omega_c t)}{\pi t}$$

so, we define the impulse response of the discrete-time system to be

$$h[n] = Th_c(nT) = T\frac{sin(\Omega_c nT)}{\pi nT} = \frac{sin(\omega_c n)}{\pi n},$$

where $\omega_c = \Omega_c T$. We have already shown that this sequence corresponds to the discrete-time Fourier transform

$$H(e^{j\omega}) = \begin{cases} 1, & |\omega| < \omega_c \\ 0, & \omega_c < |\omega| \leq \pi, \end{cases}$$

which is identical to $H_c(\frac{j\omega}{T})$, as predicted by equation, $H(e^{j\omega}) = H_c(j\frac{\omega}{T})$, $|\omega| \leq \pi$.
Algorithm-

a. Start the process.

b. Frequency domain analysis of time delay and time scaling property of signal x(n).

c. Execute the program.

d. Plot the output for each function.

e. Stop the process.

Observations-
Result- Performed frequency domain analysis of time delay and time scaling property of signal x(n).
Precautions:-

- Program must be written carefully to avoid errors.
- Programs can never be saved as standard function name.
- Commands must be written in proper format.