Q1: A signal’s values have a range of -5 V to +5 V, and you wish to make measurements with an analog quantization size no more than 5 mV. What minimum resolution A/D converter is required to perform this task?

A1: The minimum resolution is 10V / 5mV = 2000. Thus an 11-bit ADC is needed as it provides resolution in this case.

Q2: Derive the difference equation for the first-order digital low-pass filter with time constant t and sampling time T.

A2: The difference equation can be obtained by discretizing the Laplace transfer function of a low-pass filter. The discretization is usually carried out in the Backward-Euler way, which is of 1st order accuracy.

Let the transfer function be

Then, by taking the inverse Laplace transformation

The differential equation in time-domain is obtained:

Applying the Backward-Euler method:

The final difference equation for the first-order digital low-pass filter is given as follows