9.11 The following causal IIR digital transfer functions were designed using the bilinear transformation method with $T = 0.5$. Determine their respective parent causal analog transfer functions.

$$\text{(a) } G_a(z) = \frac{4(z^2+3z+4)}{10z^2+4z+6}, \qquad \text{(b) } G_b(z) = \frac{54z^3+62z^2+26z+18}{(3z+1)(12z^2-4z+8)}.$$

9.23 Design a second-order highpass filter $H_{HP}(z)$ with a 3-dB cutoff frequency at $\hat{\omega}_c = 0.47\pi$ by transforming the lowpass transfer function of Eq. (9.59) using a lowpass-to-highpass spectral transformation. Using MATLAB, plot the gain responses of the highpass and the lowpass filters on the same figure.

$$G_{LP}(z) = \frac{0.3404(1+z^{-1})^2}{1+0.1842z^{-1}+0.1776z^{-2}}. \tag{9.59}$$

M 9.1 Design a digital Butterworth lowpass filter operating at a sampling rate of 100 kHz with a 0.4-dB cutoff frequency at 10 kHz and a minimum stopband attenuation of 50 dB at 30 kHz using the bilinear transformation method. Determine the order of the analog filter prototype using the formula given in Eq. (4.35), and then design the analog prototype filter using the M-file `buttap` of MATLAB. Transform the analog filter transfer function to the desired digital transfer function using the M-file `bilinear`. Plot the gain and phase responses using MATLAB. Show all steps used in the design.