EEE598D Homework#4

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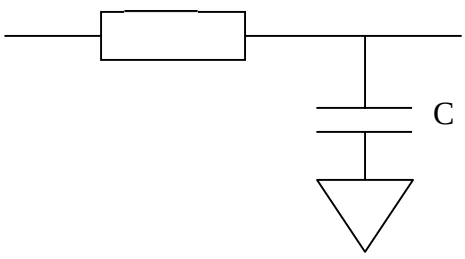
Problem 1 (s-z- transformations):

For the lowpass continuous-time filter shown in Fig.1, find the z-domain transfer functions H(z) and plot gain and phase responses versus frequency logω(0.0001π/T <ω< π/T) (i.e. Bode Plots) under

1) Forward Euler
2) Backward Euler
3) Bilinear, and
4) LDI (or midpoint) transformations

(Assuming 2π /T = 100p).



$$H_A(s) = \frac{V_o(s)}{V_i(s)} = \frac{P}{P+s}$$

$$P = \frac{1}{RC}$$

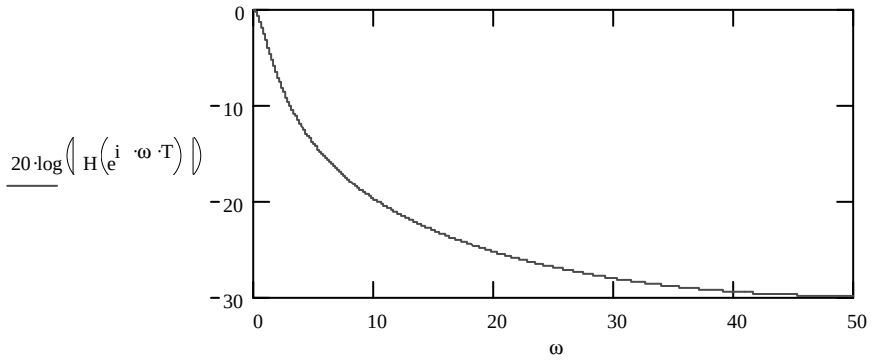
Answer:

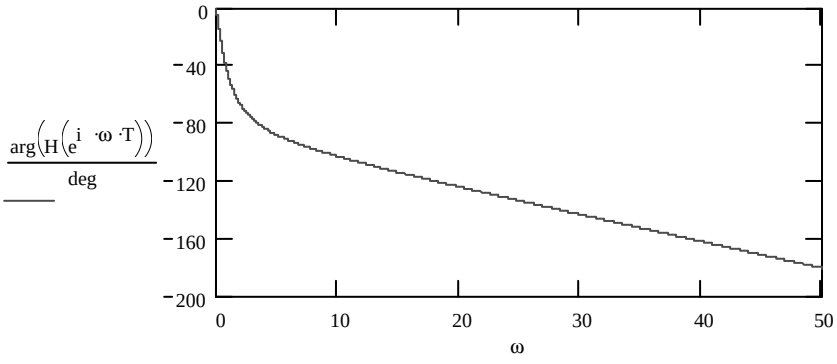
1) Forward Eular transformation we have:

$$s_a = f(z) = \frac{z-1}{T}$$

$$H(z) = \frac{V_o(z)}{V_i(z)} = \frac{P}{P + \frac{z-1}{T}} = \frac{TP}{z + TP - 1}$$

Its Bode plots are shown in the following figure:



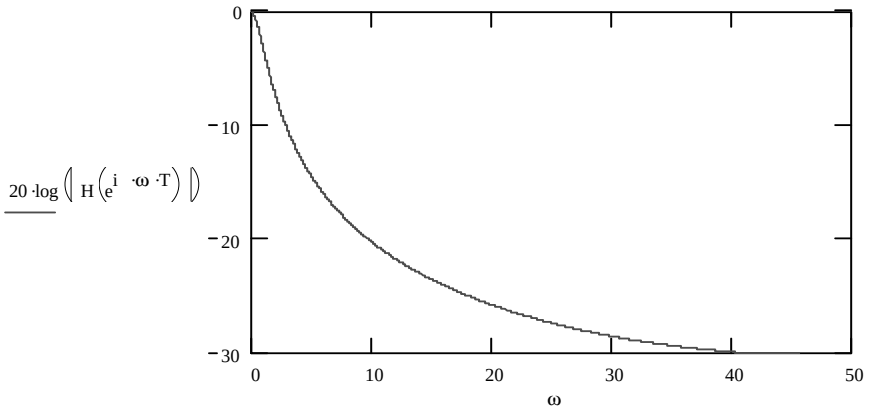


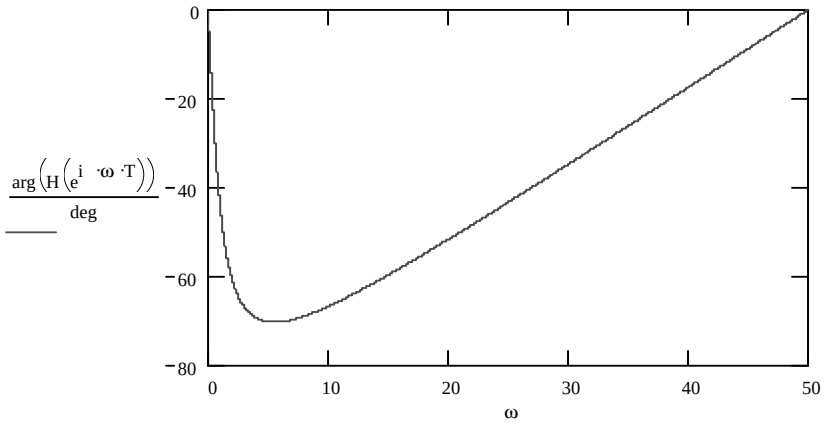
2) Backward Eular transformation we have:

$$s_a = f(z) = \frac{z-1}{Tz}$$

$$H(z) = \frac{V_o(z)}{V_i(z)} = \frac{P}{P+s} = \frac{P}{P+\frac{z-1}{Tz}} = \frac{PTz}{z-(1-PTz)}$$

Its Bode plots are shown in the following figure:



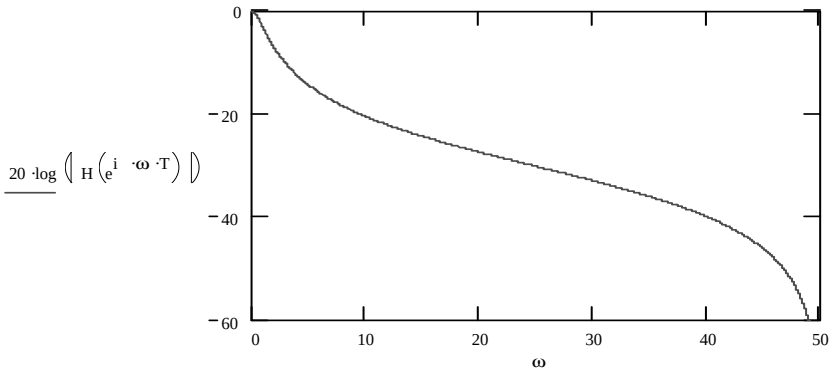


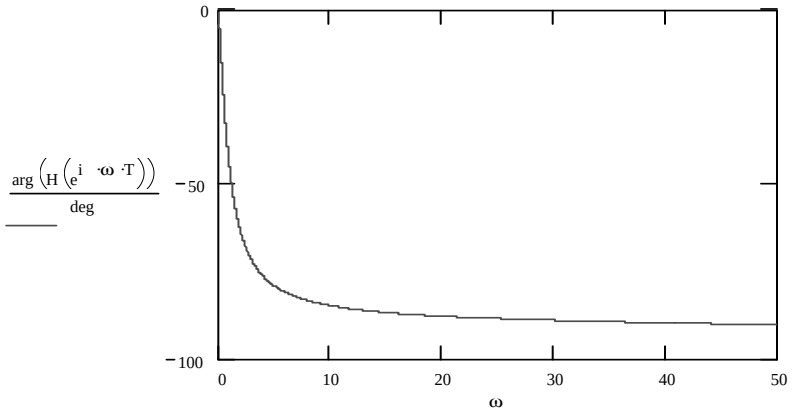
3) Bilinear transformation we have:

$$s_a = f(z) = \frac{2}{T}\frac{z-1}{z+1}$$

$$H(z) = \frac{V_o(z)}{V_i(z)} = \frac{P}{P+s} = \frac{P}{P+\frac{2}{T}\frac{z-1}{z+1}} = \frac{PT(z+1)}{PT(z+1)+2(z-1)}$$

Its Bode plots are shown in the following figure:



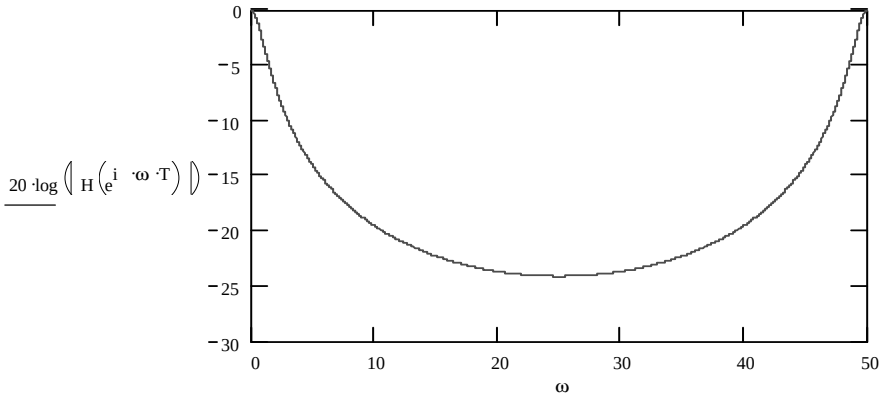


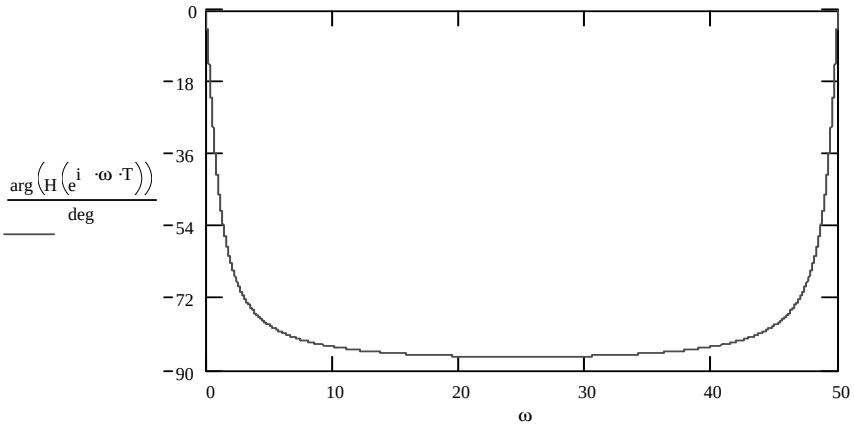
4) Midpoint transformation we have:

$$s_a = f(z) = \frac{z^2 - 1}{2Tz}$$

$$H(z) = \frac{V_o(z)}{V_i(z)} = \frac{P}{P + s} = \frac{P}{P + \dfrac{z^2 - 1}{2Tz}} = \frac{2PTz}{2PTz + (z^2 - 1)}$$

Its Bode plots are shown in the following figure:





Problem2 (warm-up reading assignment for the SC filters)

For the rest of the course (homework/course project) we are going to use the SWITCAP program as one of the tools for SC circuit simulation. A manual/tutorial of SWITCAP can be download from
http://vlsi-libra.teipir.gr/w_flash/book5/switcap/tutor.htm

Read through this tutorial and answer the following questions:

1) What is SWITCAP used for?
   It is program used to analysis switched capacitor networks.

2) What types of circuit components are used in SWITCAP?
   The program can only simulated switched capacitor network with the following ideal components:

   On-off switches
   Linear capacitors
   Linear voltage-controlled voltage sources (VCVS)
   Independent voltage sources

3) What kind of analysis can SWITCAP do?
   It can do “Frequency Domain Analyses” and “Time Domain Analyses”. Note that Z-domain quantities can also be computed.