D.8 Consider the exponential response of an STC low-pass circuit to a 10-V step input. In terms of the time constant τ, find the time taken for the output to reach 5 V, 9 V, 9.9 V, and 9.99 V.

D.9 The high-frequency response of an oscilloscope is specified to be like that of an STC LP circuit with a 100-MHz corner frequency. If this oscilloscope is used to display an ideal step waveform, what rise time (10% to 90%) would you expect to observe?

E.1 Find the transfer function \( T(s) = \frac{V_o(s)}{V_i(s)} \) of the circuit in Fig. PE.1. Is this an STC network? If so, of what type? For \( C_1 = C_2 = 0.5 \ \mu F \) and \( R = 100 \ \text{k}\Omega \), find the location of the pole(s) and zero(s), and sketch Bode plots for the magnitude response and the phase response.

D′E.2 (a) Find the voltage transfer function \( T(s) = \frac{V_o(s)}{V_i(s)} \) for the STC network shown in Fig. PE.2.

(b) In this circuit, capacitor \( C \) is used to couple the signal source \( V_i \) having a resistance \( R_i \) to a load \( R_L \). For \( R_s = 10 \ \text{k}\Omega \), design the circuit, specifying the values of \( R_L \) and \( C \) to only one significant digit to meet the following requirements:

(i) The load resistance should be as small as possible.
(ii) The output signal should be at least 70% of the input at high frequencies.
(iii) The output should be at least 10% of the input at 10 Hz.

E.7 An amplifier has a voltage transfer function \( T(s) = \frac{10^6}{s(s + 10^3)(s + 10^3)} \). Convert this to the form convenient for constructing Bode plots [that is, place the denominator factors in the form \((1 + s/\alpha)\)]. Provide a Bode plot for the magnitude response, and use it to find approximate values for the amplifier gain at 1, 10, 10^2, 10^3, 10^4, and 10^5 rad/s.

E.9 A transfer function has the following zeros and poles:
one zero at \( s = 0 \) and one zero at \( s = \infty \); one pole at \( s = -100 \) and one pole at \( s = -10^5 \). The magnitude of the transfer function at \( \omega = 10^6 \text{ rad/s} \) is 100. Find the transfer function \( T(s) \) and sketch a Bode plot for its magnitude.

E.10 Sketch Bode plots for the magnitude and phase of the transfer function

\[
T(s) = \frac{10^4(1 + s/10^5)}{(1 + s/10^3)(1 + s/10^5)}
\]

From your sketches, determine approximate values for the magnitude and phase at \( \omega = 10^6 \text{ rad/s} \).
9.1 The amplifier in Fig. P9.1 is biased to operate at $g_m = 1 \text{ mA/V}$. Neglecting $r_o$, find the midband gain. Find the value of $C_s$ that places $f_o$ at 20 Hz.

9.3 The NMOS transistor in the discrete CS amplifier circuit of Fig. P9.3 is biased to have $g_m = 5 \text{ mA/V}$. Find $A_{1p}, f_{p1}, f_{p2}, f_{p3}$, and $f_o$.

9.4 Consider the low-frequency response of the CS amplifier of Fig. 9.2(a). Let $R_{sg} = 0.5 \text{ M\Omega}$, $R_C = 2 \text{ M\Omega}$, $g_m = 3 \text{ mA/V}$, $R_o = 20 \text{ k\Omega}$, and $R_L = 10 \text{ k\Omega}$. Find $A_{1p}$. Also, design the coupling and bypass capacitors to locate the three low-frequency poles at 50 Hz, 10 Hz, and 3 Hz. Use a minimum total capacitance, with capacitors specified only to a single significant digit. What value of $f_L$ results?