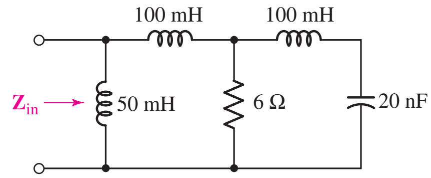
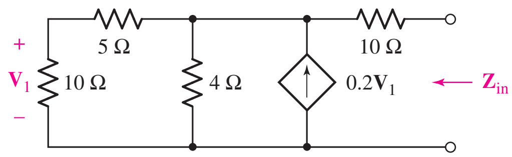
6. Calculate $\Delta_{\mathbf{Z}}$ and $\mathbf{Z}_{\text{in}}$ for the network of Fig. 17.36 if ω is equal to (*a*) 1 rad/s; (*b*) 320 krad/s.

7. Set $\omega = 100\pi$ rad/s in the one-port of Fig. 17.36. (*a*) Calculate $\Delta_{\mathbf{Y}}$ and the input admittance at ω, $\mathbf{Y}_{\text{in}}(\omega)$. (*b*) A sinusoidal current source having magnitude 100 A, frequency 100π rad/s, and 0° phase is connected to the network. Calculate the voltage across the current source (express answer as a phasor).

8. With reference to the one-port of Fig. 17.37, which contains a dependent current source controlled by a resistor voltage, (*a*) calculate $\Delta_{\mathbf{Z}}$; (*b*) compute $\mathbf{Z}_{\text{in}}$.

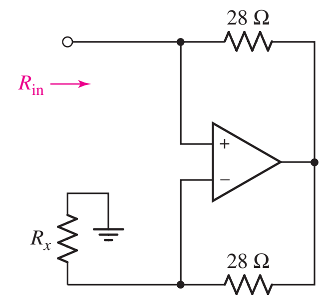


■ FIGURE 17.36



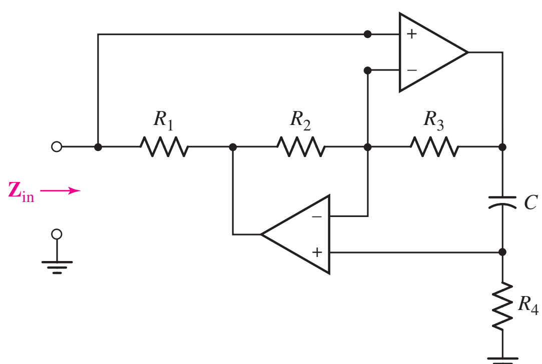
■ FIGURE 17.37

9. For the ideal op amp circuit represented in Fig. 17.38, the input resistance is defined by looking between the positive input terminal of the op amp and ground. (*a*) Write the appropriate nodal equations for the one-port. (*b*) Obtain an expression for R_{in}. Is your answer somewhat unexpected? Explain.



■ FIGURE 17.38

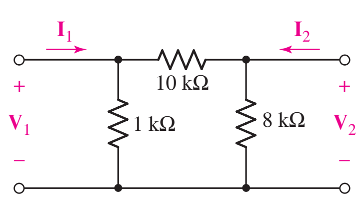
10. (*a*) If both the op amps shown in the circuit of Fig. 17.39 are assumed to be ideal ($R_i = \infty$, $R_o = 0$, and $A = \infty$), find $\mathbf{Z}_{\text{in}}$. (*b*) $R_1 = 4\ \text{k}\Omega$, $R_2 = 10\ \text{k}\Omega$, $R_3 = 10\ \text{k}\Omega$, $R_4 = 1\ \text{k}\Omega$, and $C = 200$ pF; show that $\mathbf{Z}_{\text{in}} = j\omega L_{\text{in}}$, where $L_{\text{in}} = 0.8$ mH.



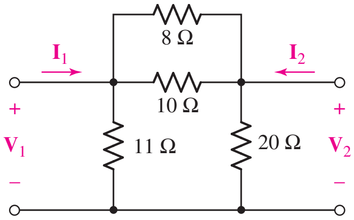
■ FIGURE 17.39

17.2 Admittance Parameters

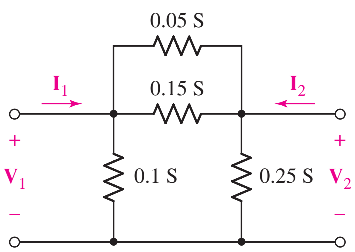
11. Obtain a complete set of **y** parameters which describe the two-port shown in Fig. 17.40.



■ FIGURE 17.40



■ FIGURE 17.41

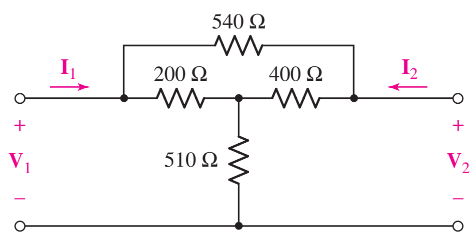


■ FIGURE 17.42

12. (a) Determine the short-circuit admittance parameters which completely describe the two-port network of Fig. 17.41. (b) If $\mathbf{V}_1 = 3$ V and $\mathbf{V}_2 = -2$ V, use your answer in part (a) to compute $\mathbf{I}_1$ and $\mathbf{I}_2$.

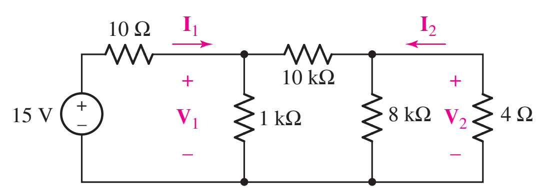
13. (a) Determine the **y** parameters for the two-port of Fig. 17.42. (b) Define the bottom node of Fig. 17.42 as the reference node, and apply nodal analysis to obtain expressions for $\mathbf{I}_1$ and $\mathbf{I}_2$ in terms of $\mathbf{V}_1$ and $\mathbf{V}_2$. Use these expressions to write down the admittance matrix. (c) If $\mathbf{V}_1 = 2\mathbf{V}_2 = 10$ V, calculate the power dissipated in the 100 mS conductance.

14. Obtain an complete set of **y** parameters to describe the two-port network depicted in Fig. 17.43.



■ FIGURE 17.43

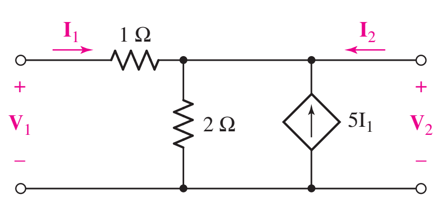
15. The circuit of Fig. 17.44 is simply the two-port of Fig. 17.40 terminated by a passive one-port and a separate one-port consisting of a voltage source in series with a resistor. (a) Determine the complete set of admittance parameters which describe the two-port network. (*Hint:* draw the two-port by itself, properly labeled with a voltage and current at each port.) (b) Calculate the power dissipated in the passive one-port, using your answer to part (a).



■ FIGURE 17.44

16. Replace the 10 Ω resistor of Fig. 17.44 with a 1 kΩ resistor, the 15 V source with a 9 V source, and the 4 Ω resistor with a 4 kΩ resistor. (a) Determine the complete set of admittance parameters which describe the two-port network consisting of the 1 kΩ, 10 kΩ, and 8 kΩ resistors. (*Hint:* draw the two port by itself, properly labeled with a voltage and current at each port.) (b) Calculate the power dissipated in the passive one-port, using your answer to part (a).

17. Determine the admittance parameters which describe the two-port shown in Fig. 17.45.

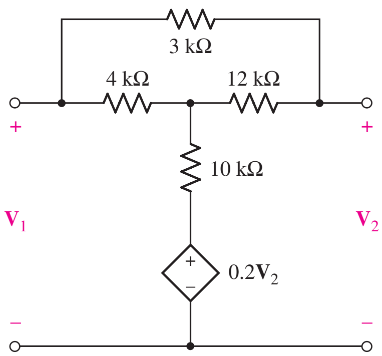


■ FIGURE 17.45

34. The network of Fig. 17.56 is terminated with a 10 Ω resistor across terminals *b* and *d*, and a 6 mA sinusoidal current source operating at 100 Hz in parallel with a 50 Ω resistor is connected across terminals *a* and *c*. Calculate the voltage, current, and power gains, respectively, as well as the input and output impedance.

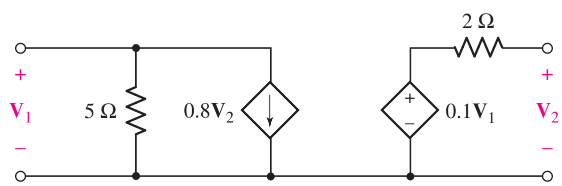
35. The two-port networks of Fig. 17.50 are connected in series. (*a*) Determine the impedance parameters for the series connection by first finding the **z** parameters of the individual networks. (*b*) If the two networks are instead connected in parallel, determine the admittance parameters of the combination by first finding the **y** parameters of the individual networks. (*c*) Verify your answer to part (*b*) by using Table 17.1 in conjunction with your answer to part (*a*).

36. (*a*) Use an appropriate method to obtain the impedance parameters which describe the network illustrated in Fig. 17.57. (*b*) If a 1 V source in series with a 1 kΩ resistor is connected to the left-hand port such that the negative reference terminal of the source is connected to the common terminal of the network, and a 5 kΩ load is connected across the right-hand terminals, compute the current, voltage, and power gain.



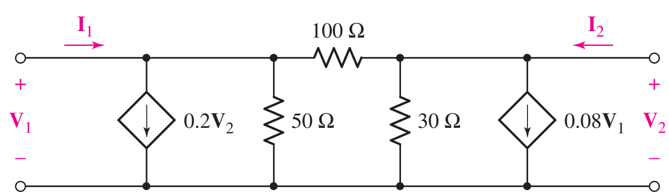
■ FIGURE 17.57

37. Determine the impedance parameters for the two-port exhibited in Fig. 17.58.



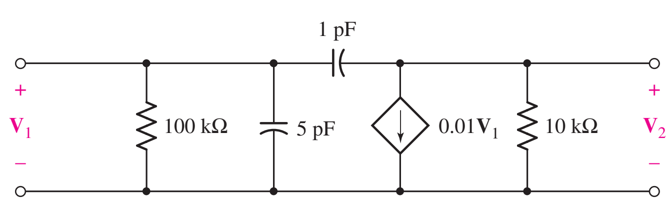
■ FIGURE 17.58

38. Obtain both the impedance and admittance parameters for the two-port network of Fig. 17.59.



■ FIGURE 17.59

39. Find the four **z** parameters at $\omega = 10^8$ rad/s for the transistor high-frequency equivalent circuit shown in Fig. 17.60.

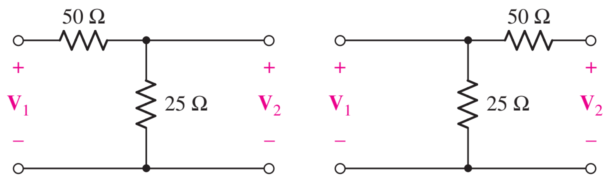


■ FIGURE 17.60

17.5 Hybrid Parameters

40. Determine the **h** parameters which describe the purely resistive network shown in Fig. 17.56 by connecting appropriate 1 V, 1 A, and short circuits to terminals as required.

41. Obtain the **h** parameters of the two-ports of Fig. 17.61.



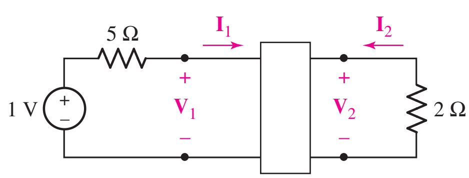
■ FIGURE 17.61

42. If **h** for some particular two-port is given by $\mathbf{h} = \begin{bmatrix} 2\ \text{k}\Omega & -3 \\ 5 & 0.01\ \text{S} \end{bmatrix}$, calculate (*a*) **z**; (*b*) **y**.

43. A certain two-port network is described by hybrid parameters $\mathbf{h} = \begin{bmatrix} 100\ \Omega & -2 \\ 5 & 0.1\ \text{S} \end{bmatrix}$. Determine the new **h** parameters if a 25 Ω resistor is connected in parallel with (*a*) the input; (*b*) the output.

44. A bipolar junction transistor is connected in common-emitter configuration, and found to have **h** parameters $h_{11} = 5\ \text{k}\Omega$, $h_{12} = 0.55 \times 10^{-4,}$ $h_{21} = 300$, and $h_{22} = 39\ \mu\text{S}$. (*a*) Write **h** in matrix form. (*b*) Determine the small-signal current gain. (*c*) Determine the output resistance in kΩ. (*d*) If a sinusoidal voltage source having frequency 100 rad/s and amplitude 5 mV in series with a 100 Ω resistor is connected to the input terminals, calculate the peak voltage which appears across the output terminals.

45. The two-port which plays a central role in the circuit of Fig. 17.62 can be characterized by hybrid parameters $\mathbf{h} = \begin{bmatrix} 1\ \Omega & -1 \\ 2 & 0.5\ \text{S} \end{bmatrix}$. Determine $\mathbf{I}_1$, $\mathbf{I}_2$, $\mathbf{V}_1$, and $\mathbf{V}_2$.

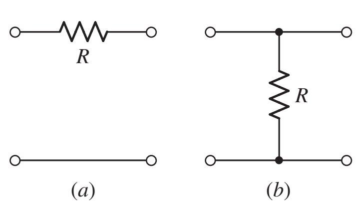


■ FIGURE 17.62

46. The two networks of Fig. 17.61 are connected in series by connecting the terminals as illustrated in Fig. 17.22 (assume the left-hand network of Fig. 17.61 is network *A*). Determine the new set of **h** parameters which describe the series connection.

47. The two networks of Fig. 17.61 are connected in parallel by tying the corresponding input terminals together, and then tying the corresponding output terminals together. Determine the new set of **h** parameters which describe the parallel connection.

48. Find **y**, **z**, and **h** for both of the two-ports shown in Fig. 17.63. If any parameter is infinite, skip that parameter set.



■ FIGURE 17.63

49. (*a*) Find **h** for the two-port of Fig. 17.64. (*b*) Find $\mathbf{Z}_{out}$ if the input contains $\mathbf{V}_s$ in series with $R_s = 200\ \Omega$.

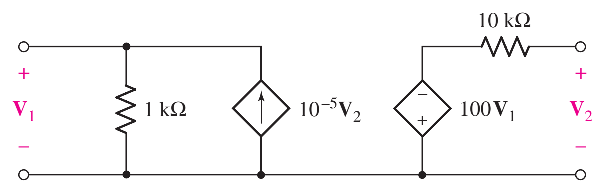


FIGURE 17.64

17.6 Transmission Parameters

50. (*a*) With the assistance of appropriate mesh equations, determine the *ABCD* matrix which represents the two-port shown in Fig. 17.9. (*b*) Convert your answer to **h**.

51. (*a*) Employ suitably written mesh equations to obtain the **t** parameters which characterize the network of Fig. 17.57. (*b*) If currents $\mathbf{I}_1$ and $\mathbf{I}_2$ are defined as flowing into the (+) reference terminals of $\mathbf{V}_1$ and $\mathbf{V}_2$, respectively, compute the voltages if $\mathbf{I}_1 = 2\mathbf{I}_2 = 3$ mA.

52. Consider the following matrices:
$$\mathbf{a} = \begin{bmatrix} 5 & 2 \\ 4 & 1 \end{bmatrix} \qquad \mathbf{b} = \begin{bmatrix} 1.5 & 1 \\ 1 & 0.5 \end{bmatrix} \qquad \mathbf{c} = \begin{bmatrix} -4 \\ 2 \end{bmatrix}$$
Calculate (*a*) $\mathbf{a} \cdot \mathbf{b}$; (*b*) $\mathbf{b} \cdot \mathbf{a}$; (*c*) $\mathbf{a} \cdot \mathbf{c}$; (*d*) $\mathbf{b} \cdot \mathbf{c}$; (*e*) $\mathbf{b} \cdot \mathbf{a} \cdot \mathbf{c}$; (*f*) $\mathbf{a} \cdot \mathbf{a}$.

53. Two networks are represented by the following impedance matrices:
$$\mathbf{z}_1 = \begin{bmatrix} 4.7 & 0.5 \\ 0.87 & 1.8 \end{bmatrix} \text{ k}\Omega \text{ and } \mathbf{z}_2 = \begin{bmatrix} 1.1 & 2.2 \\ 0.89 & 1.8 \end{bmatrix} \text{ k}\Omega\text{, respectively.}$$
(*a*) Determine the **t** matrix which characterizes the cascaded network resulting from connecting network 2 to the output of network 1. (*b*) Reverse the order of the networks and compute the new **t** matrix which results.

54. The two-port of Fig. 17.65 can be viewed as three separate cascaded two-ports *A*, *B*, and *C*. (*a*) Compute **t** for each network. (*b*) Obtain **t** for the cascaded network. (*c*) Verify your answer by naming the two middle nodes V_x and V_y, respectively, writing nodal equations, obtaining the admittance parameters from your nodal equations, and converting to **t** parameters using Table 17.1.

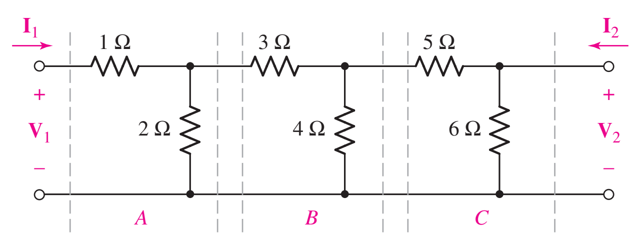


FIGURE 17.65

55. Consider the two separate two-ports of Fig. 17.61. Determine the *ABCD* matrix which characterizes the cascaded network resulting from connecting (*a*) the output of the left-hand network to the input of the right-hand network; (*b*) the output of the right-hand network to the input of the left-hand network.

56. (*a*) Determine the **t** parameters which describe the two-port of Fig. 17.58. (*b*) Compute $\mathbf{Z}_{out}$ if a practical voltage source having a 100 Ω series resistance is connected to the input terminals of the network.