(b) Devise an appropriate model.
(c) Predict the current through a 12-MΩ load.

P2-35. A device that can be represented by the mathematical model $v = 6i + 4i^2$ is connected in series with a source that can be represented by 36 V in series with 6 Ω.

(a) Predict the resulting device current mathematically.
(b) Sketch the v–i characteristic for $0 < i < 3$ and predict the device current graphically. Compare to the result for part (a)

P2-36. Device A in Fig. P2.36 is connected in series with a 20-V battery and a 5-kΩ resistance. Predict the current that flows by two methods:

(a) Reproduce the i–v characteristic and represent device A by piecewise linearization.
(b) Use the load-line method. Compare results

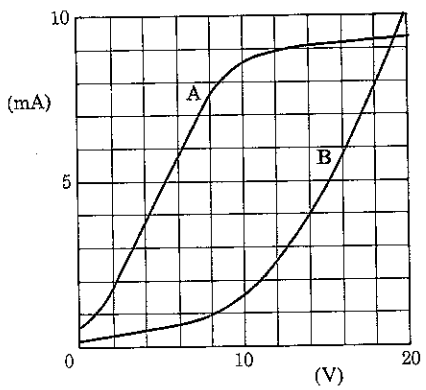

Figure P2.36 Nonlinear device characteristics

P2-37. For device A in Fig. P2.36,

(a) Reproduce the v–i characteristic and represent it by piecewise linearization.
(b) Predict the approximate current in response to an applied voltage $v = 15 + 5 \cos \omega t$ V

P2-38. Assume that device B in Fig. P2.36 can be represented by the equation $i(\text{mA}) = a_1 v + a_2 v^2$ in the region $10 \le v \le 18$ V.

(a) Evaluate a_1 and a_2 by simultaneous solution of two equations for i at the two values of v
(b) Use your mathematical model to determine i for $v = 14$ V and check graphically.

P2-39. Device B in Fig. P2.36 is connected in parallel with a 10-mA current source and a 1.8-kΩ resistance; draw the circuit and predict the voltage and the current in device B.

Answer: $v = 12.4$ V, $i = 3$ mA

P2-40. Device A in Fig. P2.36 is connected in the circuit of Fig. P2.40 where $R = 1000$ Ω and $R_1 = 600$ Ω.

(a) If $I = 16$ mA, predict the device current I_D
(b) Specify the value of I so that the power dissipated in D is 60 mW.

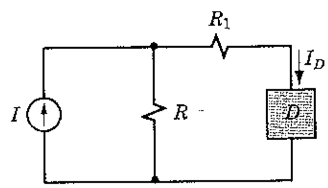

Figure P2.40

P2-41. Use the node-voltage method to calculate:

(a) The voltage across the 3-Ω resistance in Fig. P2.10
(b) The current I in Fig. P2.11. (*Hint*: Use one end of the resistance of interest as the reference node.)

P2-42. Repeat Problem 2-14 for loop *befc*.

P2-43. A black box containing a resistive circuit in it was connected to a variable load resistor R and the load power was measured as R was varied. The results are recorded in the table below.

Load power (watts)	0	5.00	5.63	5.58	5.40
R (ohms)	0	5	10	12	15

(a) Plot power versus R and estimate the power to the load resistor when $R = 3$ Ω
(b) Determine the Thévenin equivalent circuit for the circuit in the black box and use it to predict the load power when $R = 3$ Ω

Answers: (a) $P = 4$ W; (b) $R_T = 10$ Ω, $V_T = 15$ V, $P_R = 3.99$ W.

ADVANCED PROBLEMS

AP2-1. Given the circuit of Fig. AP2 1, consider various methods to calculate the current in the 5-Ω resistance. Use the method that appears to require the least algebra

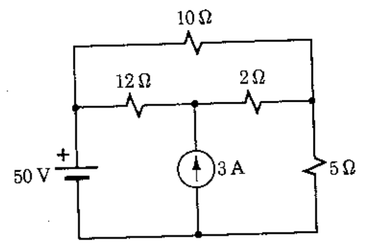

Figure AP2 1

AP2-2. In Fig AP2.2, find the voltage across the 20-Ω resistor using loop currents. If possible, choose the loop currents so that only one equation is necessary.

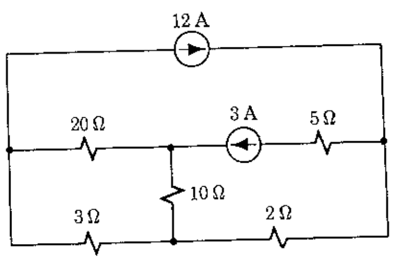

Figure AP2 2

AP2-3. (a) Draw and label a circuit showing inductors L_1 and L_2 connected in series and derive an equation for the equivalent inductance of the combination
(b) Repeat for inductances L_1 and L_2 connected in parallel

AP2-4. (a) Draw and label a circuit showing capacitors C_1 and C_2 connected in series and derive an equation for the equivalent capacitance of the combination
(b) Repeat for capacitances C_1 and C_2 connected in parallel

AP2-5. A signal generator, consisting of a complicated network of nearly linear passive and active elements, supplies a variable load resistance R_L

(a) Use Thévenin's theorem to replace the generator by a combination of V_G and R_G
(b) Prove the *maximum power transfer* theorem, which states that: "For maximum power transfer from a source to a load, the resistance of the load should be made equal to the Thévenin equivalent resistance of the source."

AP2-6. In an amplifier a transistor can be represented by the two-port model in Fig. AP2.6, where $R_1 = 10\ k\Omega$, $R_2 = 75\ k\Omega$, $R_3 = 150\ k\Omega$, and $\beta = 100$ (βI_1 is a "controlled" current source.)

(a) Simplify the model and voltage source and predict the voltage amplification V_L/V_S as a function of R_L.
(b) Calculate V_L/V_S for $R_L = 20\ k\Omega$

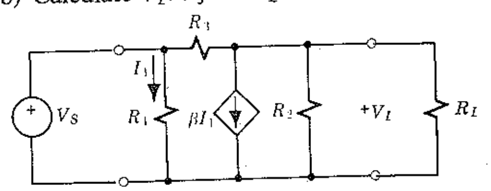

Figure AP2 6 Amplifier circuit

AP2-7. The behavior of a certain germanium diode is defined by $i = I_S(e^{bv} - 1)$ where $I_S = 13\ \mu A$ and $b = 40\ V^{-1}$.

(a) Expand the exponential term in a power series and represent $i(v)$ using the first three terms of Eq. 2-39.
(b) Predict the current if a voltage $v = +0.05$ V is applied to the diode in series with a 500-Ω resistance.
(c) Check the accuracy of the method by calculating the current using the diode voltage from part (b) in the given exponential equation.

AP2-8. Devices A and B in Fig P2 36 are connected in series and the combination in series with a 30-V battery and a 5-kΩ resistance.

(a) Plot the composite v–i characteristic for A and B in series
(b) Predict i, v_A, and v_B by the load-line method.
(c) Predict the power dissipated in devices A and B.

AP2-9. The output characteristics of two generators are:

I(A)	0	25	50	75	100
V_1(V)	120	119	117	113	105
V_2(V)	120	118	113	105	90

The two generators are connected in parallel to supply power to a load resistance $R_L = 1.0\ \Omega$. Plot the characteristics and determine graphically the current and power supplied by each generator.

AP2-10. (a) Attempt to apply node analysis to the circuit in Fig. AP2.10. What prevents us from being able to write the node equations?

(b) Using the fact that the current moving from node b into the 16-V source is the same as that moving from the 16-V source toward node a, and the fact that the relation between voltages at nodes a and b is known, write a single node equation encompassing both nodes and solve for v_a and v_b

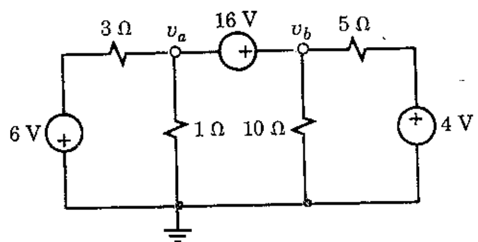

Figure AP2.10

AP2-11. Find the three currents in Fig. AP2.11

Answers: $I_1 = -1.53$ A; $I_2 = -0.68$ A; $I_3 = -0.67$ A

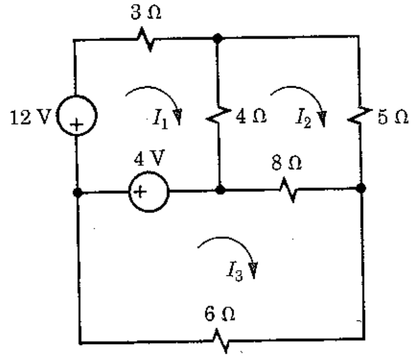

Figure AP2.11