Solution of fundamental of electric circuits

Business, Industries

Chapter 1, Problem 1 How many coulombs are represented by these amounts of electrons: (a) 6. 482 ? 1017 (b) 1. 24 ? 1018 (c) 2. 46 ? 1019 (d) 1. 628 ? 10 20 Chapter 1, Solution 1 (a) q = 6. 482x1017 x [-1. 602x10-19 C] = -0. 10384 C (b) q = 1. 24x1018 x [-1. 602x10-19 C] = -0. 19865 C (c) q = 2. 46x1019 x [-1. 602x10-19 C] = -3. 941 C (d) q = 1. 628x1020 x [-1. 602x10-19 C] = -26. 08 C Chapter 1, Problem 2. Determine the current flowing through an element if the charge flow is given by (a) q(t) = (3t + 8) mC (b) q(t) = (8t 2 + 4t-2) C (c) q (t) = 3e -t ? 5e ? 2 t nC (d) q(t) = 10 sin 120? pC (e) q(t) = 20e ? 4 t cos 50t ? C ( ) Chapter 1, Solution 2 (a) (b) (c) (d) (e) i = dq/dt = 3 mA i = dq/dt = (16t + 4) A i = dq/dt = (-3e-t + 10e-2t) nA i= dq/dt = 1200? cos 120? t pA i = dq/dt = ? e ? 4t (80 cos 50 t + 1000 sin 50 t) ? A Chapter 1, Problem 3. Find the charge q(t) flowing through a device if the current is: (a) i (t) = 3A, q(0) = 1C (b) i (t) = (2t + 5) mA, q(0) = 0 (c) i (t) = 20 cos(10t + ? / 6) ? A, q(0) = 2 ? C (d) i (t) = 10e ? 30t sin 40tA, q(0) = 0 Chapter 1, Solution 3 (a) q(t) = ? i(t)dt + q(0) = (3t + 1) C (b) q(t) = ? (2t + s) dt + q(v) = (t 2 + 5t) mC q(t) = ? 10e -30t sin 40t + q(0) = (c) q(t) = ? 20 cos (10t + ? / 6) + q(0) = (2sin(10t + ? / 6) + 1) ? C (d) 10e -30t (? 0 sin 40 t - 40 cos t) 900 + 1600 = ? e - 30t (0. 16cos40 t + 0. 12 sin 40t) C Chapter

1, Problem 4. A current of 3. 2 A flows through a conductor. Calculate how much charge passes through any cross-section of the conductor in 20 seconds. Chapter 1, Solution 4 q = it = 3. 2 x 20 = 64 C Chapter 1, Problem 5. Determine the total charge transferred over the time interval of 0 ? t ? 10s when 1 i (t) = t A. 2 Chapter 1, Solution 5 1 t 2 10 q = ? idt = ? tdt = = 25 C 2 4 0 0 PROPRIETARY MATERIAL. © 2007 The McGraw-Hill Companies, Inc. All rights reserved.

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 Chapter 3, Problem 54.

Find the mesh currents i1, i2, and i3 in the circuit in Fig. 3. 99. Figure 3. 99 Chapter 3, Solution 54 Let the mesh currents be in mA. For mesh 1, ? 12 + 10 + 2 I 1 ? I 2 = 0 ? ?> 2 = 2 I 1 ? I 2 For mesh 2, ? 10 + 3I 2 ? I 1 ? I 3 = 0 For mesh 3, ? 12 + 2 I 3 ? I 2 = 0 ? ?> ? ?> (1) 10 = ? I 1 + 3I 2 ? I 3 (2) 12 = ? I 2 + 2 I 3 (3) Putting (1) to (3) in matrix form leads to ? 2 ? 1 0 ?? I 1 ? ? 2 ? ? ?? ? ? ? ? ? 1 3 ? 1?? I 2 ? = ? 10 ? ? 0 ? 1 2 ?? I ? ? 12 ? ? ?? 3 ? ? ? Using MATLAB, ? ? > AI = B ? 5. 25 ? I = A B = ? 8. 5 ? ? ? ? 10. 25? ? ? ? 1 ? ? > I 1 = 5. 25 mA, I 2 = 8. 5 mA, I 3 = 10. 25 mA

 Chapter 3, Problem 55. In the circuit of Fig. 3. 100, solve for i1, i2, and i3. Figure 3. 100

 Chapter 3, Solution 55 10 V b I2 i1 I2 + c 1A 1A 4A 6? I1 d I3 2? i2 4A a 12 ? I4 i3 4? +– I3 I4 8V 0 It is evident that I1 = 4 For mesh 4, 12(I4 – I1) + 4(I4 – I3) – 8 = 0 6(I2 – I1) + 10 + 2I3 + 4(I3 – I4) = 0 or -3I1 + 3I2 + 3I3 – 2I4 = -5 (1) (2) (3) (4) For the supermesh At node c,

I2 = I 3 + 1 Solving (1), (2), (3), and (4) yields, I1 = 4A, I2 = 3A, I3 = 2A, and I4 = 4A At node b, At node a, At node 0, i1 = I2 – I1 = -1A i2 = 4 – I4 = 0A i3 = I4 – I3 = 2A

Chapter 3, Problem 56. Determine v1 and v2 in the circuit of Fig. 3. 101. Figure 3. 101

permission. Chapter 3, Solution 56 + v1 – 2? 2? i2 2? 2? 2? + v2 12 V + – i1 i3 –

For loop 1, 12 = 4i1 – 2i2 – 2i3 which leads to 6 = 2i1 – i2 – i3 For loop 2, 0 = 6i2 –2i1 – 2 i3 which leads to 0 = -i1 + 3i2 – i3 For loop 3, 0 = 6i3 – 2i1 – 2i2 which leads to 0 = -i1 – i2 + 3i3 In matrix form (1), (2), and (3) become, ? 2 ? 1 ? 1? ? i1 ? ? 6? ? ? 1 3 ? 1? ? i ? = ? 0? ? ?? 2 ? ? ? ? ? ? 1 ? 1 3 ? ? i 3 ? ? 0? ? ?? ? ? ? (1) (2) (3) 2 ? 1 ? 1 2 6 ? 1 ? = ? 1 3 ? 1 = 8, ? 2 = ? 1 3 ? 1 = 24 ? 1 ? 1 3 ? 1 0 3 2 ? 1 6 ? 3 = ? 1 3 0 = 24 , therefore i2 = i3 = 24/8 = 3A, ? 1 ? 1 0 v1 = 2i2 = 6 volts, v = 2i3 = 6 volts PROPRIETARY MATERIAL. © 2007 The McGraw-Hill Companies, Inc. All rights reserved.

No part of this Manual may be displayed, reproduced or distributed in any form or by any means, without the prior written permission of the publisher, or used beyond the limited distribution to teachers and educators permitted by McGraw-Hill for their individual course preparation. If you are a student using this Manual, you are using it without permission. Chapter 3, Problem 57. In the circuit in Fig. 3. 102, find the values of R, V1, and V2 given that io = 18 mA. Figure 3. 102 Chapter 3, Solution 57 Assume R is in kilo-ohms. V2 = 4k? x18mA = 72V , V1 = 100 ? V2 = 100 ? 72 = 28V Current through R is 3 3 iR = io , V1 = i R R ? > 28 = (18) R 3+ R 3+ R This leads to R = 84/26 = 3. 23 k ? PROPRIETARY MATERIAL. © 2007 The McGraw-Hill Companies, Inc. All rights reserved. No part of this Manual may be displayed, reproduced or distributed in any form or by any means, without the prior written permission of the publisher, or used beyond the limited distribution to teachers and educators permitted by McGraw-Hill for their individual course preparation. If you are a student using this Manual, you are using it without permission.

Chapter 3, Problem 58. Find i1, i2, and i3 the circuit in Fig. 3. 103. Figure 3. 103 Chapter 3, Solution 58 30 ? i2 30 ? 10 ? 10 ? 30 ? i1 + i3 20 V – For loop 1, 120 + 40i1 – 10i2 = 0, which leads to -12 = 4i1 – i2 For loop 2, 50i2 – 10i1 – 10i3 = 0, which leads to -i1 + 5i2 – i3 = 0 For loop 3, -120 – 10i2 + 40i3 = 0, which leads to 12 = -i2 + 4i3 Solving (1), (2), and (3), we get, i1 = -3A, i2 = 0, and i3 = 3A (1) (2) (3) Chapter 3, Problem 59. Rework Prob. 3. 30 using mesh analysis. Chapter 3, Problem 30. Using nodal analysis, find vo and io in the circuit of Fig. 3. 79. Figure 3. 79 Chapter 3, Solution 59 40 ? –+ I0 10 ? 20 ? i2 120 V + 100V + i1 – 4v0 + – 2I0 i2 i3 v0 80 ? – i3 For loop 1, -100 + 30i1 – 20i2 + 4v0 = 0, where v0 = 80i3 or 5 = 1. 5i1 – i2 + 16i3 For the supermesh, 60i2 – 20i1 – 120 + 80i3 – 4 v0 = 0, where v0 = 80i3 or 6 = -i1 + 3i2 – 12i3 Also, 2I0 = i3 – i2 and I0 = i2, hence, 3i2 = i3 ? 3 ? 2 32 ? ? ? 1 3 ? 12? ? ? ? 1 ? 3 ? 0 ? ? ? i1 ? ? 10? ? i ? = ? 6 ? ? 2? ? ? ? i 3 ? ? 0 ? ? ? ? ? (1) (2) (3) From (1), (2), and (3), 3 ? 32 3 10 32 3 ? 2 10 ? = ? 1 3 ? 12 = 5, ? 2 = ? 1 6 ? 12 = ? 28, ? 3 = ? 1 3 6 = ? 84 0 3 ? 1 0 0 ? 1 0 3 0 I0 = i2 = ? 2/? = -28/5 = -5. 6 A v0 = 8i3 = (-84/5)80 = -1. 344 kvolts Chapter 3, Problem 60. Calculate the power dissipated in each resistor in the circuit in Fig. 3. 104. Figure 3. 104 Chapter 3, Solution 60 0. 5i0 4? 10 V 8? v1 1? 10 V + v2 2? – i0 At node 1, (v1/1) + (0. 5v1/1) = (10 – v1)/4, which leads to v1 = 10/7 At node 2, (0. 5v1/1) + ((10 – v2)/8) = v2/2 which leads to v2 = 22/7 P1? = (v1)2/1 = 2. 041 watts, P2? = (v2)2/2 = 4. 939 watts P4? = (10 – v1)2/4 = 18. 38 watts, P8? = (10 – v2)2/8 = 5. 88 watts Chapter 3, Problem 61. Calculate the current gain io/is in the circuit of Fig. 3.

105. Figure 3. 105 Chapter 3, Solution 61 v1 is 20 ? v2 10 ? i0 + v0 – 30 ? – + 5v0 40 ?

At node 1, is = (v1/30) + ((v1 – v2)/20) which leads to 60is = 5v1 – 3v2 But v2 = -5v0 and v0 = v1 which leads to v2 = -5v1 Hence, 60is = 5v1 + 15v1 = 20v1 which leads to v1 = 3is, v2 = -15is i0 = v2/50 = -15is/50 which leads to i0/is = -15/50 = –0. 3 (1) Chapter 3, Problem 62. Find the mesh currents i1, i2, and i3 in the network of Fig. 3. 106. Figure 3. 106 Chapter 3, Solution 62 4 k? A 8 k? B 2 k? 100V + – i1 i2 i3 + – 40 V We have a supermesh. Let all R be in k? , i in mA, and v in volts. For the supermesh, -100 +4i1 + 8i2 + 2i3 + 40 = 0 or 30 = 2i1 + 4i2 + i3 At node A, At node B, i1 + 4 = i2 i2 = 2i1 + i3 (1) (2) (3) Solving (1), (2), and (3), we get i1 = 2 mA, i2 = 6 mA, and i3 = 2 mA. Chapter 3, Problem 63. Find vx, and ix in the circuit shown in Fig. 3. 107.

Figure 3. 107 Chapter 3, Solution 63 10 ? A 5? 50 V + – i1 i2 + – 4ix For the supermesh, -50 + 10i1 + 5i2 + 4ix = 0, but ix = i1.

Hence, 50 = 14i1 + 5i2 At node A, i1 + 3 + (vx/4) = i2, but vx = 2(i1 – i2), hence, i1 + 2 = i2 Solving (1) and (2) gives i1 = 2. 105 A and i2 = 4. 105 A vx = 2(i1 – i2) = –4 volts and ix = i2 – 2 = 2. 105 amp (1) (2) Chapter 3, Problem 64. Find vo, and io in the circuit of Fig. 3. 108. Figure 3. 108

Chapter 3, Solution 64 i1 50 ? A i2 10 ? + ? i0 10 ? i2 i1 100V + + – 4i0 i3 40 ? – 0. 2V0 2A B i1 i3 For mesh 2, 20i2 – 10i1 + 4i0 = 0 (1) (2) But at node A, io = i1 – i2 so that (1) becomes i1 = (16/6)i2 For the supermesh, -100 + 50i1 + 10(i1 – i2) – 4i0 + 40i3 = 0 or At node B, But, 50 = 28i1 – 3i2 + 20i3 i3 + 0. 2v0 = 2 + i1 v0 = 10i2 so that (4) becomes i3 = 2 + (2/3)i2 (3) (4) (5) Solving (1) to (5), i2 = 0. 11764, v0 = 10i2 = 1. 1764 volts, i0 = i1 - i2 =

(5/3)i2 = 196. 07 mA Chapter 3, Problem 65. Use MATLAB to solve for the mesh currents in the circuit of Fig. 3. 109. Figure 3. 109 Chapter 3, Solution 65 For mesh 1, –12 + 12I1 – 6I2 – I4 = 0 or 12 = 12I 1 ? 6 I 2 ?

I 4 For mesh 2, For mesh 3, For mesh 4, For mesh 5, –6I1 + 16I2 – 8I3 – I4 – I5 = 0 –8I2 + 15I3 – I5 – 9 = 0 or 9 = –8I2 + 15I3 – I5 –I1 – I2 + 7I4 – 2I5 – 6 = 0 or 6 = –I1 – I2 + 7I4 – 2I5 –I2 – I3 – 2I4 + 8I5 – 10 = 0 or 10 = ? I 2 ? I 3 ? 2 I 4 + 8I 5 (2) (3) (4) (5) (1) Casting (1) to (5) in matrix form gives 1 0 ?? I1 ? ? 12 ? ? 12 ? 6 0 ?? ? ? ? ? ? ? 6 16 ? 8 ? 1 ? 1 ?? I 2 ? ? 0 ? ? 0 ? 8 15 0 ? 1 ?? I ? = ? 9 ? ?? 3 ? ? ? ? 7 ? 2 ?? I 4 ? ? 6 ? ? ? 1 ? 1 0 ? 0 ? 1 ? 1 ? 2 8 ?? I ? ? 10 ? ?? 5 ? ? ? ? ? ? > AI = B Using MATLAB we input: Z=[12,-6, 0,-1, 0;-6, 16,-8,-1,-1; 0,-8, 15, 0,-1;-1,-1, 0, 7,-2; 0,-1,-1,-2, 8] and V=[12; 0; 9; 6; 10] This leads to >>

Z=[12,-6, 0,-1, 0;-6, 16,-8,-1,-1; 0,-8, 15, 0,-1;-1,-1, 0, 7,-2; 0,-1,-1,-2, 8] Z= 12 -6 0 -1 0 -6 0 -1 16 -8 -1 -8 15 0 -1 0 7 -1 -1 -2 0 -1 -1 -2 8 gt;> V=[12; 0; 9; 6; 10] V= 12 0 9 6 10 >> I= inv(Z)*V I= 2. 1701 1. 9912 1. 8119 2. 0942 2. 2489 Thus, I = [2. 17, 1. 9912, 1. 8119, 2. 094, 2. 249] A.

Chapter 3, Problem 66. Write a set of mesh equations for the circuit in Fig. 3. 110. Use MATLAB to determine the mesh currents. 10 ? 10 ? 8? 12 V + _ 6? 4? I1 + _ 2? I2 24 V + _ 6? 8? 40 V 2? I4 4? 8? 30 V + _ I3 8? 4? I5 + _ 32 V Figure 3. 110 For Prob. 3. 66. Chapter 3, Solution 66 The mesh equations are obtained as follows. ? 12 + 24 + 30I1 ? 4I2 ? 6I3 ? 2I4 = 0 or 30I1 – 4I2 – 6I3 – 2I4 = –12 ? 24 + 40 ? 4I1 + 30I2 ? 2I4 ? 6I5 = 0 or –4I1 + 30I2 – 2I4 – 6I5 = –16 –6I1 + 18I3 – 4I4 = 30 –2I1 – 2I2 – 4I3 + 12I4 –4I5 = 0 –6I2 – 4I4 + 18I5 = –32 (1) 2) (3) (4) (5) Putting (1) to (5) in matrix form ? 30 ? 4 ? 6 ? 2 0 ? ? ? 12 ? ?? 30 0 ? 2 ? 6? ? ? 16 ? ? ? ? ? ? ? 6 0 18 ? 4 0 ? I = ? 30 ? ? ? ? ? ?? 2 ? 2 ?

4 12 ? 4? ? 0 ? ? 0 ? 6 0 ? 4 18 ? ?? 32? ? ? ? ? ZI = V Using MATLAB, >> Z = [30,-4,-6,-2, 0; -4, 30, 0,-2,-6; -6, 0, 18,-4, 0; -2,-2,-4, 12,-4; 0,-6, 0,-4, 18] Z= 30 -4 -6 -2 0 -4 30 0 -2 -6 -6 0 18 -4 0 -2 0 -2 -6 -4 0 12 -4 -4 18 >> V = [-12,-16, 30, 0,-32]' V= -12 -16 30 0 -32 ;; I = inv(Z)*V I= -0. 2779 A -1. 0488 A 1. 4682 A -0. 4761 A -2. 2332 A Chapter 3, Problem 67. Obtain the node-voltage equations for the circuit in Fig. 3. 111 by inspection. Then solve for Vo. 2A 4? 2? + Vo _ 3 Vo 10 ? 5? 4A Figure 3. 111 For Prob. 3. 67. Chapter 3, Solution 67 Consider the circuit below. A V1 4? V2 2? + Vo - V3 3 Vo 10 ? 5? 4A 0 ? ? 0. 35 ? 0. 25 ?? 2 + 3Vo ? ?? 0. 25 0. 95 ? 0. 5? V = ? ? 0 ? ? ? ? ? 0 ? ? ? 0. 5 0. 5 ? 6 ? ? ? ?

Since we actually have four unknowns and only three equations, we need a constraint equation. Vo = V2 – V3 Substituting this back into the matrix equation, the first equation becomes, 0. 35V1 – 3. 25V2 + 3V3 = –2 This now results in the following matrix equation, 3 ? ? 0. 35 ? 3. 25 ? ? 2? ?? 0. 25 0. 95 ? 0. 5? V = ? 0 ? ? ? ? ? ? 0 ? 6? ? 0. 5 0. 5 ? ? ? ? ? Now we can use MATLAB to solve for V. ;; Y=[0. 35,-3. 25, 3;-0. 25, 0. 95,-0. 5; 0,-0. 5, 0. 5] Y= 0. 3500 -3. 2500 3. 0000 -0. 2500 0. 9500 -0. 5000 0 -0. 5000 0. 5000 ;; I=[-2, 0, 6]' I= -2 0 6 >> V= inv(Y)*I V= -164. 105 -77. 8947 -65. 8947 Vo = V2 – V3 = –77. 89 + 65. 89 = –12 V. Let us now do a quick check at node 1. –3(–12) + 0. 1(–164. 21) + 0. 25(–164. 21+77. 89) + 2 = +36 – 16. 421 – 21. 58 + 2 = –0. 001; answer checks! Chapter 3, Problem 68. Find the voltage Vo in the circuit of Fig. 3. 112. 3A 10 ? + 4A 40 ? Vo _ 25 ? 20 ? + _ 24 V Figure 3. 112 For Prob. 3. 68. Chapter 3, Solution 68 Consider the circuit below. There are two non-reference nodes. 3A V1 10 ? + Vo 25 ? 4A 40 ? Vo _ 20 ? + _ 24 V ? +4+3 ? ? 7 ? ? 0. 125 ? 0. 1? ? ? 0. 1 0. 19 ? V = ?? 3 + 24 / 25? = ?? 2. 04? ? ? ? ? ? ? Using

MATLAB, we get, >> Y=[0. 125,-0. 1;-0. 1, 0. 19] Y= 0. 1250 -0. 1000 -0. 1000 0. 1900 >> I=[7,-2. 04]' I= 7. 0000 -2. 400 ;; V= inv(Y)*I V= 81. 8909 32. 3636 Thus, Vo = 32. 36 V. We can perform a simple check at node Vo, 3 + 0. 1(32. 36–81. 89) + 0. 05(32. 36) + 0. 04(32. 36–24) = 3 – 4. 953 + 1. 618 + 0. 3344 = – 0. 0004; answer checks! Chapter 3, Problem 69. For the circuit in Fig. 3. 113, write the node voltage equations by inspection. Figure 3. 113 Chapter 3, Solution 69 Assume that all conductances are in mS, all currents are in mA, and all voltages are in volts. G11 = (1/2) + (1/4) + (1/1) = 1. 75, G22 = (1/4) + (1/4) + (1/2) = 1, G33 = (1/1) + (1/4) = 1. 25, G12 = -1/4 = -0. 25, G13 = -1/1 = -1, G21 = -0. 25, G23 = -1/4 = -0. 25, G31 = -1, G32 = -0. 25 i1 = 20, i2 = 5, and i3 = 10 – 5 = 5 The node-voltage equations are: 1 ? ? v 1 ? ? 20? ? 1. 75 ? 0. 25 ? ? 0. 25 1 ? 0. 25? ? v 2 ? = ? 5 ? ? ?? ? ? ? ? 0. 25 1. 25 ? ? v 3 ? ? 5 ? ? ? ? 1 ?? ? ? ?

Chapter 3, Problem 70. Write the node-voltage equations by inspection and then determine values of V1 and V2 in the circuit in Fig. 3. 114. V1 ix 4A 1S 2S 4ix V2 5S 2A Figure 3. 114 For Prob. 3. 70. Chapter 3, Solution 70 ? 4I x + 4 ? ? 3 0? ? 0 5 ? V = ? ? 4 I ? 2 ? x ? ? ? ? ? With two equations and three unknowns, we need a constraint equation, Ix = 2V1, thus the matrix equation becomes, ? ? 5 0? ? 4? V=? ? ? 8 5? ? ? ? ? 2? This results in V1 = 4/(–5) = –0. 8V and V2 = [–8(–0. 8) – 2]/5 = [6. 4 – 2]/5 = 0. 88 V. Chapter 3, Problem 71. Write the mesh-current equations for the circuit in Fig. 3. 115. Next, determine the values of I1, I2, and I3. 5? I1 I3 3? 10 V + _ 1? 2? 4? I2 + _ 5V Figure 3. 15 For Prob. 3. 71. Chapter 3, Solution 71 ? 9 ? 4 ? 5? ? 10 ? ?? 4 7 ? 1? I = ?? 5? ? ? ? ? ?? 5 ? 1 9 ? ? 0 ? ? ? ? ?

We can now use MATLAB solve for our currents. ;; R=[9,-4,-5;-4, 7,-1;-5,-1, 9] R= 9 -4 -5 -4 7 -1 -5 -1 9 ;; V=[10,-5, 0]' V= 10 -5 0 >> I= inv(R)*V I= 2. 085

A 653. 3 mA 1. 2312 A

Chapter 3, Problem 72. By inspection, write the mesh-current equations for the circuit in Fig. 3. 116. Figure 3. 116 Chapter 3, Solution 72 R11 = 5 + 2 = 7, R22 = 2 + 4 = 6, R33 = 1 + 4 = 5, R44 = 1 + 4 = 5, R12 = -2, R13 = 0 = R14, R21 = -2, R23 = -4, R24 = 0, R31 = 0, R32 = -4, R34 = -1, R41 = 0 = R42, R43 = -1, we note that Rij = Rji for all i not equal to j. v1 = 8, v2 = 4, v3 = -10, and v4 = -4 Hence the mesh-current equations are: 0 ? i1 ? ? 8 ? ? 7 ? 2 0 ? ? 2 6 ? 4 0 ? ? i ? ? 4 ? ? ? ?? 2 ? = ? ? 0 ? 4 5 ? 1? ? i 3 ? ? ? 10? ? ? ?? ? ? 0 ? 1 5 ? ? i 4 ? ? ? 4 ? ? 0

Chapter 3, Problem 73. Write the mesh-current equations for the circuit in Fig. 3. 117. Figure 3. 117 Chapter 3, Solution 73 R11 = 2 + 3 +4 = 9, R22 = 3 + 5 = 8, R33 = 1+1 + 4 = 6, R44 = 1 + 1 = 2, R12 = -3, R13 = -4, R14 = 0, R23 = 0, R24 = 0, R34 = -1 v1 = 6, v2 = 4, v3 = 2, and v4 = -3 Hence, ? 9

? 3 ? 4 0 ? ? i1 ? ? 6 ? ?? 3 8 0 0 ? ? i 2 ? ? 4 ? ?? ? = ? ? ? ?? 4 0 6 ? 1? ? i3 ? ? 2 ? ?? ? ? ? ? 0 ? 1 2 ? ? i 4 ? ?? 3? ? 0 Chapter 3, Problem 74. By inspection, obtain the mesh-current equations for the circuit in Fig. 3. 11. Figure 3. 118 Chapter 3, Solution 74

R11 = R1 + R4 + R6, R22 = R2 + R4 + R5, R33 = R6 + R7 + R8, R44 = R3 + R5 + R8, R12 = -R4, R13 = -R6, R14 = 0, R23 = 0, R24 = -R5, R34 = -R8, again, we note that Rij = Rji for all i not equal to j. ? V1 ? ?? V ? 2? The input voltage vector is = ? ? V3 ? ? ? ? ? V4 ? ? R 1 + R 4 + R 6 ? ? R4 ? ? R6 ? ? 0 ? ? R4 R2 + R4 + R5 0 ? R5 ? R6 0 R6 + R7 + R8 ? R8 0 ? ? i 1 ? ? V1 ? ? ? i ? ? ? V ? ? R5 2? ?? 2 ? = ? ? R8 ? ? i 3 ? ? V3 ? ? ?? ? ? R 3 + R 5 + R 8 ? ? i 4 ? ? ? V4 ? Chapter 3, Problem 75. Use PSpice to solve Prob. 3. 58. Chapter 3, Problem 58 Find i1, i2, and i3 the circuit in Fig. 3. 103. Figure 3. 103 Chapter 3, Solution 75 * Schematics Netlist * R_R4 R_R2 R_R1 R_R3 R_R5 V_V4 v_V3 v_V2 v_V1 $N_0002 $N_0001 30 $N_0001 $N_0003 10 $N_0005 $N_0004 30 $N_0003 $N_0004 10 $N_0006 $N_0004 30 $N_0003 0 120V $N_0005 $N_0001 0 0 $N_0006 0 0 $N_0002 0 3 i1 i2 Clearly, i1 = –3 amps, i2 = 0 amps, and i3 = 3 amps, which agrees with the answers in Problem 3. 44. Chapter 3, Problem 76.

Use PSpice to solve Prob. 3. 27. Chapter 3, Problem 27 Use nodal analysis to determine voltages v1, v2, and v3 in the circuit in Fig. 3. 76. Figure 3. 76 Chapter 3, Solution 76 to teachers and educators permitted by McGraw-Hill for their individual course preparation.

If you are a student using this Manual, you are using it without permission. * Schematics Netlist * I_I2 R_R1 R_R3 R_R2 F_F1 VF_F1 R_R4 R_R6 I_I1 R_R5 0 $N_0001 DC 4A $N_0002 $N_0001 0. 25 $N_0003 $N_0001 1 $N_0002 $N_0003 1 $N_0002 $N_0001 VF_F1 3 $N_0003 $N_0004 0V 0 $N_0002 0. 5 0 $N_0001 0. 5 0 $N_0002 DC 2A 0 $N_0004 0. 25 Clearly, v1 = 625 mVolts, v2 = 375 mVolts, and v3 = 1. 625 volts, which agrees with the solution obtained in Problem 3. 27. Chapter 3, Problem 77. Solve for V1 and V2 in the circuit of Fig. 3. 119 using PSpice. PROPRIETARY MATERIAL. 2007 The McGraw-Hill Companies, Inc. All rights reserved. No part of this Manual may be displayed, reproduced or distributed in any form or by any means, without the prior written permission of the publisher, or used beyond the limited distribution to teachers and educators permitted by McGraw-Hill for their individual course preparation. If you are a student using this Manual, you are using it without permission. 2 ix V1 5? V2 5A 2? ix 1? 2A Figure 3. 119 For Prob. 3. 77. Chapter 3, Solution 77 PROPRIETARY MATERIAL. © 2007 The McGraw-Hill Companies, Inc.

All rights reserved. No part of this Manual may be displayed, reproduced or distributed in any form or by any means, without the prior written permission of the publisher, or used beyond the limited distribution to teachers and educators permitted by McGraw-Hill for their individual course preparation. If you are a student using this Manual, you are using it without permission. As a check we can write the nodal equations, ? 1. 7 ? 0. 2? ? 5? V=? ? ?? 1. 2 1.

2 ? ? ? ? ? 2? Solving this leads to V1 = 3. 111 V and V2 = 1. 4444 V. The answer checks!

Chapter 3, Problem 78. Solve Prob. 3. 20 using PSpice. Chapter 3, Problem 20 For the circuit in Fig. 3. 9, find V1, V2, and V3 using nodal analysis. Figure 3. 69 Chapter 3, Solution 78 The schematic is shown below.

When the circuit is saved and simulated the node voltages are displaced on the pseudocomponents as shown. Thus, V1 = ? 3V, V2 = 4. 5V, V3 = ? 15V, . Chapter 3, Problem 79. Rework Prob. 3. 28 using PSpice.

If you are a student using this Manual, you are using it without permission. Chapter 3, Problem 28 Use MATLAB to find the voltages at nodes a, b, c, and d in the circuit of Fig. 3. 77. Figure 3. 77 Chapter 3, Solution 79 The schematic is shown below. When the circuit is saved and simulated, we obtain the node voltages as displaced. Thus, Va = ? 5. 278 V, Vb = 10. 28 V, Vc = 0. 6944 V, Vd = ? 26. 88 V Chapter 3, Problem 80. Find the nodal voltage v1 through v4 in the circuit in Fig. 3. 120 using PSpice. Figure 3. 120 Chapter 3, Solution 80 * Schematics Netlist * H_H1 VH_H1 I_I1 V_V1 R_R4 R_R1 R_R2 R_R5 R_R3 $N_0002 $N_0003 VH_H1 6 0 $N_0001 0V $N_0004 $N_0005 DC 8A $N_0002 0 20V 0 $N_0003 4 $N_0005 $N_0003 10 $N_0003 $N_0002 12 0 $N_0004 1 $N_0004 $N_0001 2

Clearly, v1 = 84 volts, v2 = 4 volts, v3 = 20 volts, and v4 = -5. 333 volts Chapter 3, Problem 81. Use PSpice to solve the problem in Example 3. 4

Example 3. 4 Find the node voltages in the circuit of Fig. 3. 12. Figure 3. 12 Chapter 3, Solution 81

Clearly, v1 = 26. 67 volts, v2 = 6. 667 volts, v3 = 173. 33 volts, and v4 = -46. 67 volts which agrees with the results of Example 3. 4. This is the netlist for this circuit. * Schematics Netlist * R_R1 R_R2 R_R3 R_R4 R_R5 I_I1 V_V1 E_E1 0 $N_0001 2 $N_0003 $N_0002 6 0 $N_0002 4 0 $N_0004 1 $N_0001 $N_0004 3 0 $N_0003 DC 10A $N_0001 $N_0003 20V $N_0002 $N_0004 $N_0001 $N_0004 3 Chapter 3, Problem 82. If the Schematics Netlist for a network is as follows, draw the network.

 R_R1 R_R2 R_R3 R_R4 R_R5 V_VS I_IS F_F1 VF_F1 E_E1 1 2 2 3 1 4 0 1 5 3 2 0 0 4 3 0 1 3 0 2 2K 4K 8K 6K 3K DC DC VF_F1 0V 1 100 4 2 3 3 Chapter 3, Solution 82 2i0 + v0 – 3 k? 1 4A 2 k? 2 + 3v0 3 6 k? 4 4 k? 8 k? 100V + – 0

This network corresponds to the Netlist. Chapter 3, Problem 83. The following program is the Schematics Netlist of a particular circuit.

Draw the circuit and determine the voltage at node 2. R_R1 R_R2 R_R3 R_R4 V_VS I_IS 1 2 2 3 1 2 2 0 3 0 0 0 20 50 70 30 20V DC 2A Chapter 3, Solution 83 The circuit is shown below. 1 20 ? 2 70 ? 3 20 V + – 50 ? 2A 30 ? 0 When the circuit is saved and simulated, we obtain v2 = –12. 5 volts Chapter 3, Problem 84. Calculate vo and io in the circuit of Fig. 3. 121. Figure 3. 121 Chapter 3, Solution 84 From the output loop, v0 = 50i0x20x103 = 106i0 (1) From the input loop, 3x10-3 + 4000i0 – v0/100 = 0 (2) From (1) and (2) we get, i0 = 0. 5?

A and v0 = 0. 5 volt. Chapter 3, Problem 85.

 An audio amplifier with resistance 9? supplies power to a speaker.

In order that maximum power is delivered, what should be the resistance of the speaker? Chapter 3, Solution 85 The amplifier acts as a source. Rs + Vs RL For maximum power transfer, R L = R s = 9? Chapter 3, Problem 86. For the simplified transistor circuit of Fig. 3. 122, calculate the voltage vo. Figure 3. 122 Chapter 3, Solution 86 Let v1 be the potential across the 2 k-ohm resistor with plus being on top. Then, [(0. 03 – v1)/1k] + 400i = v1/2k (1) Assume that i is in mA. But, i = (0. 03 – v1)/1 Combining (1) and (2) yields, v1 = 29. 963 mVolts and i = 37. nA, therefore, v0 = -5000x400x37. 4x10-9 = -74. 8 mvolts (2) Chapter 3, Problem 87. For the circuit in Fig. 3. 123, find the gain vo/vs.

Figure 3. 123 Chapter 3, Solution 87 v1 = 500(vs)/(500 + 2000) = vs/5 v0 = -400(60v1)/(400 + 2000) = -40v1 = -40(vs/5) = -8vs, Therefore, v0/vs = –8 Chapter 3, Problem 88. Determine the gain vo/vs of the transistor amplifier circuit in Fig. 3. 124. Figure 3. 124 Chapter 3, Solution 88 Let v1 be the potential at the top end of the 100-ohm resistor. (vs – v1)/200 = v1/100 +

(v1 – 10-3v0)/2000 For the right loop, v0 = -40i0(10, 000) = -40(v1 – 10-3)10, 000/2000, or, v0 = -200v1 + 0. 2v0 = -4x10-3v0 (2) (1) Substituting (2) into (1) gives, (vs + 0. 004v1)/2 = -0. 004v0 + (-0. 04v1 – 0. 001v0)/20 This leads to 0. 125v0 = 10vs or (v0/vs) = 10/0. 125 = -80 Chapter 3, Problem 89. For the transistor circuit shown in Fig. . 125, find IB and VCE. Let ? = 100 and VBE = 0. 7V. _ 3V + _ 1 k? 0. 7 V + 100 k? | | 15 V Figure 3. 125 For Prob. 3. 89. Chapter 3, Solution 89 Consider the circuit below. _ 0. 7 V C + 100 k? + IC VCE _ 3V + _ E For the left loop, applying KVL gives VBE = 0. 7 ? 3 ? 0. 7 + 100 x103 IB + VBE = 0 ???? IB = 30 ? A > For the right loop, ? VCE + 15 ? Ic(1x10 3) = 0 But IC = ? IB = 100 x30 ? A= 3 mA | | 15 V 1 k? VCE = 15 ? 3 x10 ? 3 x103 = 12 V Chapter 3, Problem 90. Calculate vs for the transistor in Fig. 3. 126, given that vo = 4 V, ? = 150, VBE = 0. 7V. Figure 3. 126 Chapter 3, Solution 90 1 k? 10 k? IB + VBE + VCE – i2 + vs + – - i1 18V

500 ? + V0 - IE – For loop 1, -vs + 10k(IB) + VBE + IE (500) = 0 = -vs + 0. + 10, 000IB + 500(1 + ?)IB which leads to vs + 0. 7 = 10, 000IB + 500(151)IB = 85, 500IB But, v0 = 500IE = 500x151IB = 4 which leads to IB = 5. 298x10-5 Therefore, vs = 0. 7 + 85, 500IB = 5. 23 volts Chapter 3, Problem 91. For the transistor circuit of Fig. 3. 127, find IB, VCE, and vo. Take ? = 200, VBE = 0. 7V. Figure 3. 127 Chapter 3, Solution 91 We first determine the Thevenin equivalent for the input circuit. RTh = 6|| 2 = 6x2/8 = 1. 5 k? and VTh = 2(3)/(2+6) = 0. 75 volts 5 k? IC 1. 5 k? IB + VBE + VCE – i2 + + 0. 75 V – - i1 9V 400 ? + V0 - IE B – For loop 1, -0. 75 + 1. 5kIB + VBE + 400IE = 0 = -0. 75 + 0. 7 + 1500IB + 400(1 + ?)IB B B IB = 0. 05/81, 900 = 0. 61 ? A B v0 = 400IE = 400(1 + ? IB = 49 mV B For loop 2, -400IE – VCE – 5kIC + 9 = 0, but, IC = ? IB and IE = (1 + ?)IB B B VCE = 9 – 5k? IB – 400(1 + ?)IB = 9 – 0. 659 = 8. 641 volts B B Chapter 3, Problem 92.

 Find IB and VC for the circuit in Fig. 3. 128. Let ? = 100, VBE = 0. 7V. Figure 3. 128 Chapter 3, Solution 92 10 k? I1 5 k? VC IC IB + + VBE 4 k? VCE – – 12V + + V0 - IE – I1 = IB + IC = (1 + ?)IB and IE = IB + IC = I1 Applying KVL around the outer loop, 4kIE + VBE + 10kIB + 5kI1 = 12 12 – 0. 7 = 5k(1 + ?)IB + 10kIB + 4k(1 + ?)IB = 919kIB IB = 11. 3/919k = 12. 296 ? A Also, 12 = 5kI1 + VC which leads to VC = 12 – 5k(101)IB = 5. 791 volts Chapter 3, Problem 93 Rework Example 3. 1 with hand calculation. In the circuit in Fig. 3. 34, determine the currents i1, i2, and i3. Figure 3. 34 Chapter 3, Solution 93 ? 4? v1 i1 2? i 2? 3v0 v2 i3 + 8? 2? 3v0 i2 4? i + v0 + + v2 24V + + v1 – – – – (a) (b) From (b), -v1 + 2i – 3v0 + v2 = 0 which leads to i = (v1 + 3v0 – v2)/2 At node 1 in (a), ((24 – v1)/4) = (v1/2) + ((v1 +3v0 – v2)/2) + ((v1 – v2)/1), where v0 = v2 or 24 = 9v1 which leads to v1 = 2. 667 volts At node 2, ((v1 – v2)/1) + ((v1 + 3v0 – v2)/2) = (v2/8) + v2/4, v0 = v2 v2 = 4v1 = 10. 66 volts Now we can solve for the currents, i1 = v1/2 = 1. 333 A, i2 = 1. 333 A, and i3 = 2. 6667 A.

 Chapter 4, Problem 1. Calculate the current io in the circuit of Fig. 4. 69. What does this current become when the input voltage is raised to 10 V? Figure 4. 69 Chapter 4, Solution 1. + ? 8 (5 + 3) = 4? , i = io = 1 1 = 1+ 4 5 1 i= = 0. 1A 2 10 Since the resistance remains the same we get i = 10/5 = 2A which leads to io = (1/2)i = (1/2)2 = 1A. Chapter 4, Problem 2.

Find vo in the circuit of Fig. 4. 70. If the source current is reduced to 1 ? A, what is vo? Figure 4. 70 Chapter 4, Solution 2. 6 (4 + 2) = 3? , i1 = i 2 = io = 1 A 2 1 1 i1 = , v o = 2i o = 0. 5V 2 4 If is = 1? A, then vo = 0. 5? V Chapter 4, Problem 3. (a) In the circuit in Fig. 4. 71, calculate vo and Io when vs = 1 V. (b) Find vo and io when vs = 10 V. (c) What are vo and Io when each of the 1-? resistors is replaced by a 10-? resistor and vs = 10 V? Figure 4. 71 Chapter 4, Solution 3. + ? + vo + ? (a) We transform the Y sub-circuit to the equivalent ? . 3R 2 3 3 3 3 = R, R + R = R R 3R = 4R 4 4 4 2 vs vo = independent of R 2 io = vo/(R) When vs = 1V, vo = 0. 5V, io = 0. 5A (b) When vs = 10V, vo = 5V, io = 5A (c) When vs = 10V and R = 10? vo = 5V, io = 10/(10) = 500mA Chapter 4, Problem 4. Use linearity to determine io in the circuit in Fig. 4. 72. Figure 4. 72 Chapter 4, Solution 4.

If Io = 1, the voltage across the 6? resistor is 6V so that the current through the 3? resistor is 2A. + v1 3 6 = 2? , vo = 3(4) = 12V, i1 = Hence Is = 3 + 3 = 6A If Is = 6A Is = 9A Io = 1 Io = 9/6 = 1. 5A vo = 3A. 4 Chapter 4, Problem 5. For the circuit in Fig. 4. 73, assume vo = 1 V, and use linearity to find the actual value of vo. Figure 4. 73 Chapter 4, Solution 5. + ? If vo = 1V, ? 1? V1 = ? ? + 1 = 2V ? 3? 10 ? 2? Vs = 2? ? + v1 = 3 ? 3? If vs =

10 3 vo = 1 vo = 3 x15 = 4. 5V 10 Then vs = 15 Chapter 4, Problem 6. For the linear circuit shown in Fig. 4. 74, use linearity to complete the following table. Experiment 1 2 3 4 Vs 12 V -1V -Vo 4V 16 V --2V + Vs + _ Linear Circuit Vo – Figure 4. 74

For Prob. 4. 6. Chapter 4, Solution 6. Due to linearity, from the first experiment, 1 Vo = Vs 3 Applying this to other experiments, we obtain: Experiment 2 3 4 Vs 48 1V -6 V Vo 16 V 0. 333 V -2V Chapter 4, Problem 7. Use linearity and the assumption that Vo = 1V to find the actual value of Vo in Fig. 4. 75. . 1? 4? + 4V + _ 3? 2? Vo _ Figure 4. 75 For Prob. 4. 7. Chapter 4, Solution 7. If Vo = 1V, then the current through the 2-? and 4-? resistors is ? = 0. 5. The voltage across the 3-? resistor is ? (4 + 2) = 3 V. The total current through the 1-? resistor is 0. 5 +3/3 = 1. 5 A. Hence the