



















$$32 + 210 + 810 + 10 = 1143$$

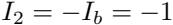


V bcd b

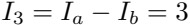
$$3x^2 - 4x + 20 = 0$$

$$\begin{cases} 10I_a & -8I_b = 32 \\ -8I_a & +12I_b = -20 \end{cases} \Rightarrow \begin{cases} I_a = 4 \\ I_b = 1 \end{cases}$$











2020-2021



WOW  
=

WOW  
=

WOW  
=

WAVES ARE







22 + 21 = 43

$$910 + 10 = 100$$

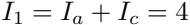


$$32 + 2i + 4i + 20 = 0$$

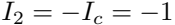
22 + 21 = 43

$$22 + 2i + 4i + 20 = 20$$

$$\begin{cases} 10I_a + 2I_c = 32 \\ 2I_a + 6I_c = 12 \end{cases} \xRightarrow{\quad} \begin{cases} I_a = 3 \\ I_c = 1 \end{cases}$$

























$$\sum_i I_i = 0 = I_1 + I_2 + I_3$$

$$I_1 = \frac{V_a - V_b}{R_{ab}} = \frac{32 - V_b}{2}, \quad I_2 = \frac{V_c - V_b}{R_{cb}} = \frac{20 - V_b}{4}, \quad I_3 = \frac{V_d - V_b}{R_{bd}} = \frac{0 - V_b}{8}$$

$$I_1 + I_2 + I_3 = \frac{32 - \sqrt{b}}{2} + \frac{20 - \sqrt{b}}{4} + \frac{0 - \sqrt{b}}{8} = 0$$



15/10/2024

25/06/2024-14





1234567890-1234567890











$$\Sigma_i \frac{V - V_i}{R_i} + \Sigma_k \frac{V}{R_k} = \Sigma_j I_j$$

$$V = \frac{\sum_i V_i/R_i + \sum_j I_j}{\sum_i 1/R_i + \sum_k 1/R_k} = \frac{\sum I}{\sum G}$$





$$\sum_j (I - I_j) R_j + \sum_k I R_k = \sum_i I v_i$$



$$I = \frac{\sum_i V_i + \sum_j R_j I_j}{\sum_i R_j + \sum_k R_k} = \frac{\sum V}{\sum R}$$

loop bacb:	$-V_{s1} + R_1 I_a + R_3(I_a - I_b) + R_4(I_a - I_c) + V_{s4} = 0$
loop adca:	$R_2 I_b + V_{s2} + R_5(I_b - I_c) + R_3(I_b - I_a) = 0$
loop bcdb:	$-V_{s4} + R_4(I_c - I_a) + R_5(I_c - I_b) + R_6 I_c - V_{s6} = 0$

$$\begin{array}{lcl}
 \text{node a:} & (V_a - (V_b + V_{s1}))/R_1 + (V_a - V_{s2})/R_2 + (V_a - V_c)/R_3 = 0 \\
 \text{node b:} & (V_b - (V_a - V_{s1}))/R_1 + (V_b + V_{s4} - V_c)/R_4 + (V_b - V_{s6})/R_6 = 0 \\
 \text{node c:} & (V_c - (V_b + V_{s4}))/R_4 + (V_c - V_a)/R_3 + V_c/R_5 = 0
 \end{array}$$















1234567890

$$\begin{cases} R_2(I_2 - I_1) + R_3(I_2 - I_3) - V = 0 \\ R_1(I_3 - I_1) + R_4 I_3 + R_3(I_3 - I_2) = 0 \end{cases}$$

$$\begin{cases} 14I_2 - 6I_3 = 10 \\ -6I_2 + 13I_3 = 1.5 \end{cases} \xRightarrow{\quad} \begin{cases} I_2 = 0.952 \\ I_3 = 0.555 \end{cases}$$





$$V_2 = R_2 / (1 + R_2 / (8 / (0.5 - 0.952) = -3.616 V$$

WISCONSIN  
+  
WISCONSIN  
WISCONSIN









$$\begin{cases} (V_1 - V_3)/R_4 + (V_1 - V_2)/R_1 = I \\ (V_2 - V_1)/R_1 + (V_2 - V_3)/R_3 + V_2/R_2 = 0 \end{cases}$$

$$\begin{cases} 7V_1 - 4V_2 = -12 \\ -8V_1 + 15V_2 = -24 \end{cases} \Rightarrow \begin{cases} V_1 = -3.78 \\ V_2 = -3.616 \end{cases}$$













11

11

110000







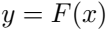


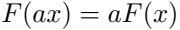












$$\frac{d}{dx} \left( x^2 + \frac{1}{x} \right) = \frac{d}{dx} \left( x^2 + x^{-1} \right)$$



$\frac{d}{dx} \left( x^2 + 1 \right) = 2x$







1991

1992

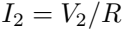






$$I_{12} = \frac{aV_1 + bV_2}{R} = a\frac{V_1}{R} + b\frac{V_2}{R} = aI_1 + bI_2$$





$$V = R(dI_1 + dI_2) = dI_1 R + dI_2 R = dV_1 + dV_2$$





$$P_{12} = \frac{(V_1 + V_2)^2}{R} \neq \frac{V_1^2}{R} + \frac{V_2^2}{R} = P_1 + P_2, \quad P_{12} = R(I_1 + I_2)^2 \neq RI_1^2 + RI_2^2 = P_1 + P_2$$

$$I_1' = \frac{32}{2+8||4} = \frac{48}{7}, \quad I_2' = I_1' \frac{8}{8+4} = \frac{32}{7}, \quad I_3' = I_1' \frac{4}{8+4} = \frac{16}{7}$$



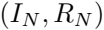
$$I_2'' = \frac{20}{4 + 8\sqrt{2}} = \frac{25}{7}, \quad I_1'' = -I_2'' \frac{8}{2 + 8} = -\frac{20}{7}, \quad I_3'' = I_2'' \frac{2}{8 + 2} = \frac{5}{7}$$

$$I_1 = I_1' + I_1'' = \frac{48}{7} - \frac{20}{7} = 4, \quad I_2 = I_2' + I_2'' = \frac{25}{7} - \frac{32}{7} = -1, \quad I_3 = I_3' + I_3'' = \frac{16}{7} + \frac{5}{7} = 3$$

























A pixelated, black and white graphic of the text "VW + VW volvo". The letters are thick and blocky, with a jagged, pixelated edge. The "V" and "W" are in a standard font, while the "volvo" is in a lowercase, rounded font. The plus sign is a simple cross. The entire graphic is set against a white background.









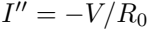






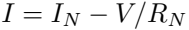












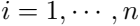




**VORABBRUF**

$$R_T = R_N = \frac{V_{oc}}{I_{sc}}$$





$$V = \frac{\sum_{i=1}^n \frac{V_i}{R_i}}{\sum_{i=1}^n \frac{1}{R_i}}$$













2020

$$\begin{cases} R'_{ab} = R_a + R_b = R_{ab} || (R_{ac} + R_{bc}) \\ R'_{ac} = R_a + R_c = R_{ac} || (R_{ab} + R_{bc}) \\ R'_{bc} = R_b + R_c = R_{bc} || (R_{ab} + R_{ac}) \end{cases}$$















$$\begin{cases} R_a = R_{ab}R_{ac}/(R_{ab} + R_{ac} + R_{bc}) \\ R_b = R_{ab}R_{bc}/(R_{ab} + R_{ac} + R_{bc}) \\ R_c = R_{ac}R_{bc}/(R_{ab} + R_{ac} + R_{bc}) \end{cases}$$

$$\left\{ \begin{array}{l} R_{ab} = R_a + R_b + R_a R_b / R_c \\ R_{ac} = R_a + R_c + R_a R_c / R_b \\ R_{bc} = R_b + R_c + R_b R_c / R_a \end{array} \right.$$









$$\begin{cases} Y_1 = Z_1 Z_3 / (Z_1 + Z_2 + Z_3) \\ Y_2 = Z_2 Z_3 / (Z_1 + Z_2 + Z_3) \\ Y_3 = Z_1 Z_2 / (Z_1 + Z_2 + Z_3) + Z_4 \end{cases}$$



$$\begin{cases} X_1 = Z_1 + Z_4 + Z_1 Z_4 / Z_2 \\ X_2 = Z_2 + Z_4 + Z_2 Z_4 / Z_1 \\ X_3 = (Z_1 + Z_2 + Z_1 Z_2 / Z_4) || Z_3 \end{cases}$$



WAVES FOR THE

1.  $\frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$



$$I_N = V_R / R = V_0 / R + I_0, \quad I_N R = V_0 + I_0 R$$





$$I_{R2} + I_{R0} + I_{R1} = I_{R0}$$

$$I = \frac{V_0 - I_0 R_1}{R_1 + R_2}$$



$$I_0 + I_1 + I_2 = I_0 + \frac{V - V_0}{R_1} + \frac{V}{R_2} = 0,$$

$$I_0 I_1 I_2 + I_2 I_3 I_4 + I_4 I_5 I_6 = 0$$



$$V = \frac{R_2 V_0 - I_0 R_1 R_2}{R_1 + R_2} = V_0 \frac{R_2}{R_1 + R_2} - I_0 \frac{R_1 R_2}{R_1 + R_2}$$

$$I = I_2 = \frac{V}{R_2} = \frac{V_0}{R_1 + R_2} - I_0 \frac{R_1}{R_1 + R_2}$$





$$I' = \frac{V_0}{R_1 + R_2}, \quad V' = I' R_2 = V_0 \frac{R_2}{R_1 + R_2}$$





$$I'' = -I_0 \frac{R_1}{R_1 + R_2}, \quad V'' = I'' R_2 = -I_0 \frac{R_1 R_2}{R_1 + R_2}$$



$$I = I' + I'' = \frac{V_0}{R_1 + R_2} - I_0 \frac{R_1}{R_1 + R_2}$$

$$V = V' + V'' = V_0 \frac{R_2}{R_1 + R_2} - I_0 \frac{R_1 R_2}{R_1 + R_2}$$

A pixelated, grayscale illustration of the text "I = VO RI". The characters are rendered in a blocky, digital font style. The "I" and "R" have a slight shadow or gradient effect. The "=" is composed of two horizontal bars. The "V" and "O" are also pixelated, with the "O" being a simple outline. The "I" at the end is smaller than the first one. The entire image has a low-resolution, 1-bit aesthetic.

$$I = \left( \frac{V_0}{R_1} - I_0 \right) \frac{R_1}{R_1 + R_2} = \frac{V_0}{R_1 + R_2} - I_0 \frac{R_1}{R_1 + R_2}$$

$$V = R_2 I = V_0 \frac{R_2}{R_1 + R_2} - I_0 \frac{R_1 R_2}{R_1 + R_2}$$

THE VOYAGE OF THE  
"ALBATROSS" TO THE  
POLE

$$I = \frac{V_T}{R_T + R_2} = \frac{V_0 - I_0 R_1}{R_1 + R_2} = \frac{V_0}{R_1 + R_2} - I_0 \frac{R_1}{R_1 + R_2}$$

BRUNNEN  
BRUNNEN  
BRUNNEN



$$I = \left( \frac{V_T}{R_1} - I_0 \right) \frac{R_T}{R_T + R_2} = \frac{V_0}{R_1 + R_2} - I_0 \frac{R_1}{R_1 + R_2}$$

10

10

10

123456789















$$\begin{cases} R_2(I_0 - I_1) + R_4(I_0 - I_2) = 3(I_0 - I_1) + 1.5(I_0 - I_2) = 18 \\ R_1I_1 + R_5(I_1 - I_3) + R_2(I_1 - I_0) = 3I_1 + 2(I_1 - I_3) + 3(I_1 - I_0) = 0 \\ R_3I_2 + R_4(I_2 - I_0) + R_5(I_2 - I_1) = 6I_2 + 1.5(I_2 - I_0) + 2(I_2 - I_1) = 0 \end{cases}$$

$$\begin{cases} 3I_0 - 2I_1 - I_2 = 12 \\ -3I_0 + 8I_1 - 2I_2 = 0 \\ 3I_0 + 4I_1 - 19I_2 = 0 \end{cases} \Rightarrow \begin{cases} I_0 = 32/5 \\ I_1 = 14/5 \\ I_2 = 8/5 \end{cases}$$

$$V_a = R_3 I_2 = 6 \times \frac{8}{5} = \frac{48}{5}, \quad V_b = R_4 (I_0 - I_2) = 1.5 \times \frac{24}{5} = \frac{36}{5}, \quad V_{ab} = V_a - V_b = \frac{12}{5}$$

$$I_1 - I_2 = \frac{14}{5} - \frac{8}{5} = 1.2 \text{ A,}$$

$$I = \frac{V_a - V_b}{R_5} = \frac{12/5 \text{ V}}{2 \Omega} = 1.2 \text{ A}$$

10

10

10

10

$$\frac{V_a - V_0}{R_1} + \frac{V_a - V_b}{R_5} + \frac{V_a}{R_3} = \frac{V_a - 18}{3} + \frac{V_a - V_b}{2} + \frac{V_a}{6} = 0$$



$$\frac{V_b - V_0}{R_2} + \frac{V_b - V_a}{R_5} + \frac{V_b}{R_4} = \frac{V_b - 18}{3} + \frac{V_b - V_a}{2} + \frac{V_b}{1.5} = 0$$

$$\begin{cases} -V_a + 3V_b = 12 \\ 2V_a - V_b = 12 \end{cases} \xRightarrow{\quad} \begin{cases} V_a = 48/5 \\ V_b = 36/5 \end{cases}$$

$$I = \frac{V_a - V_b}{R_5} = \frac{(48/5 - 36/5) \text{ V}}{2 \Omega} = \frac{12/5 \text{ V}}{2 \Omega} = \frac{6}{5} = 1.2 \text{ A}$$





$$\frac{V_a - 18}{3} + 0.5 + \frac{V_a}{6} = 0, \quad \frac{V_b - 18}{3} - 0.5 + \frac{V_b}{1.5} = 0$$







$$R_5 = \frac{v_a - v_b}{1} = \frac{11 - 6.5}{0.5} = 9 \Omega$$



$$R_c = \frac{R_1 R_2}{R_1 + R_2 + R_5} = \frac{9}{8}, \quad R_a = \frac{R_1 R_5}{R_1 + R_2 + R_5} = \frac{3}{4}, \quad R_b = \frac{R_2 R_5}{R_1 + R_2 + R_5} = \frac{3}{4}$$

$$R_0 = R_c + (R_a + R_3) || (R_b + R_4) = \frac{45}{16}$$

$$I_0 = \frac{V_0}{R_0} = \frac{18}{45/16} = \frac{32}{5}$$

$$I_a = I_0 \frac{R_b + R_4}{(R_a + R_3) + (R_b + R_4)} = \frac{8}{5}$$

$$I_b = I_0 \frac{R_a + R_3}{(R_a + R_3) + (R_b + R_4)} = \frac{24}{5}$$

$$V_a = I_a \times R_3 = \frac{8}{5} \times 6 = \frac{48}{5}, \quad V_b = I_b \times R_4 = \frac{24}{5} \times 1.5 = \frac{36}{5}$$



$$I = \frac{V_a - V_b}{R_5} = \frac{12}{5} \times \frac{1}{2} = 1.2A$$





$$V_T = V_{oc} = V_0 \frac{R_3}{R_1 + R_3} - V_0 \frac{R_4}{R_2 + R_4} = 18 \left( \frac{6}{9} - \frac{1.5}{4.5} \right) = 6V$$

$$R_T = R_1 || R_3 + R_2 || R_4 = \frac{3 \times 6}{3 + 6} + \frac{3 \times 1.5}{3 + 1.5} = 3 \Omega$$

$$I = \frac{V_T}{R_T + R_5}$$



1 = 0.5 + 1.5





1 = 0.9 + 0.1 = 1.0



1 = 0.3 + 0.1

ABSTRACTS OF THE  
PROCEEDINGS OF THE  
ANNUAL MEETING OF THE  
AMERICAN SOCIETY OF  
CLIMATE ENGINEERS  
HOLDING COMPANY

$$R_1 = 2V, R_2 = 80V, R_1 = 15V, R_2 = 3V, R_1 = 2V$$











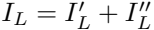
























VB = 1B 1B = 3B 2B = 7B

VB VB 1.5 x B 7.5 = 10.5





12/10/2025 10:53:05

11 5 12 + 12 5 12 + 8 12 5

$$V_1 = B_1 \times I_1 + V_0 = 1.5 \times 14.5 + 19.5 = 41.25$$

VR1/VR1  
= 2/41.25  
= 90/50

A pixelated, black and white graphic of the text "I S EXPOSED". The letters are thick and blocky, with a jagged, pixelated edge. The "I" and "S" are on the left, followed by a space, then "EXPOSED". The "E" is particularly large and prominent. The overall style is reminiscent of early digital art or a low-resolution scan of a printed document.











VB1B1B2B3B4B5B6B7B8B9

VB + B I + 15 x 2 + 7.5

3. 1. 5. 5.

15 + 25 + 25 = 75

$$\sqrt{2} = \sqrt{2} \times \sqrt{2} = 2$$

V2/V2  
500/25  
22/11

11-22-2011



$$I_L = I' - I'' = \frac{96 \times 8}{55} - \frac{96}{11} = \frac{288}{55}$$



1. 2. 3. 4. 5. 6. 7. 8. 9. 10. 11. 12. 13. 14. 15. 16. 17. 18. 19. 20. 21. 22. 23. 24. 25. 26. 27. 28. 29. 30. 31. 32. 33. 34. 35. 36. 37. 38. 39. 40. 41. 42. 43. 44. 45. 46. 47. 48. 49. 50. 51. 52. 53. 54. 55. 56. 57. 58. 59. 60. 61. 62. 63. 64. 65. 66. 67. 68. 69. 70. 71. 72. 73. 74. 75. 76. 77. 78. 79. 80. 81. 82. 83. 84. 85. 86. 87. 88. 89. 90. 91. 92. 93. 94. 95. 96. 97. 98. 99. 100.

$$V_0 = V_1 \times R_2 / (R_1 + R_2) = 72 \times 2 / (1.5 + 2) = 48$$

$$\sqrt[3]{\frac{V_2}{R_2}} = \sqrt[3]{\frac{V_3}{R_3}} = \sqrt[3]{\frac{1.80}{1.5}} = \sqrt[3]{2.5} = 30$$

1990-2019

$$B_1|B_2+B_3|B_4=3|1.5+2.5|1.5=7.5/4$$

$$I_L = \frac{V_T}{R_T + R_L} = \frac{18}{7.75/4 + 1.5} = \frac{288}{55}$$













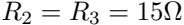
$$\frac{V_a - 5}{2} + \frac{V_a}{2} + \frac{V_a - V_b}{3} = 0, \quad \frac{V_b - V_a}{3} + \frac{V_b - 5}{6} + 0.5 = 0$$







ABOVE 15-23/05-40













$$\begin{cases} V_1 = Z_{11}I_1 + Z_{12}I_2 \\ V_2 = Z_{21}I_1 + Z_{22}I_2 \end{cases} \quad \begin{bmatrix} V_1 \\ V_2 \end{bmatrix} = \begin{bmatrix} Z_{11} & Z_{12} \\ Z_{21} & Z_{22} \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \mathbf{Z} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix}$$











12

12

12

12



$$\begin{cases} I_1 = Y_{11}V_1 + Y_{12}V_2 \\ I_2 = Y_{21}V_1 + Y_{22}V_2 \end{cases} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} Y_{11} & Y_{12} \\ Y_{21} & Y_{22} \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \end{bmatrix} = \mathbf{Y} \begin{bmatrix} V_1 \\ V_2 \end{bmatrix}$$













$$\begin{cases} V_1 = A_{11}V_2 + A_{12}(-I_2) \\ I_1 = A_{21}V_2 + A_{22}(-I_2) \end{cases} \begin{bmatrix} V_1 \\ I_1 \end{bmatrix} = \begin{bmatrix} A_{11} & A_{12} \\ A_{21} & A_{22} \end{bmatrix} \begin{bmatrix} V_2 \\ -I_2 \end{bmatrix} = \mathbf{A} \begin{bmatrix} V_2 \\ -I_2 \end{bmatrix}$$









21

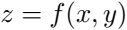
$$\begin{cases} V_1 = H_{11}I_1 + H_{12}V_2 \\ I_2 = H_{21}I_1 + H_{22}V_2 \end{cases} \begin{bmatrix} V_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} H_{11} & H_{12} \\ H_{21} & H_{22} \end{bmatrix} \begin{bmatrix} I_1 \\ V_2 \end{bmatrix} = \mathbf{H} \begin{bmatrix} I_1 \\ V_2 \end{bmatrix}$$



121













$$\Delta z = \Delta f(x, y) = \frac{\partial f}{\partial x} \Delta x + \frac{\partial f}{\partial y} \Delta y$$

$$\frac{\partial f}{\partial x} = \lim_{\Delta x \rightarrow 0} \frac{\Delta f}{\Delta x} \bigg|_{\Delta y = 0}$$

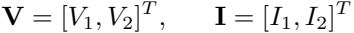
$$\frac{\partial f}{\partial y} = \lim_{\Delta y \rightarrow 0} \frac{\Delta f}{\Delta y} \bigg|_{\Delta x = 0}$$

$$Z_{11} = \frac{V_1}{I_1} \bigg|_{I_2=0}, \quad Z_{12} = \frac{V_1}{I_2} \bigg|_{I_1=0}, \quad Z_{21} = \frac{V_2}{I_1} \bigg|_{I_2=0}, \quad Z_{22} = \frac{V_2}{I_2} \bigg|_{I_1=0}$$

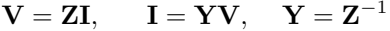
$$Y_{11} = \frac{I_1}{V_1} \bigg|_{V_2=0}, \quad Y_{12} = \frac{I_1}{V_2} \bigg|_{V_1=0}, \quad Y_{21} = \frac{I_2}{V_1} \bigg|_{V_2=0}, \quad Y_{22} = \frac{I_2}{V_2} \bigg|_{Y_1=0},$$

$$A_{11} = \frac{V_1}{V_2} \bigg|_{I_2=0}, \quad A_{12} = \frac{V_1}{I_2} \bigg|_{V_2=0}, \quad A_{21} = \frac{I_1}{V_2} \bigg|_{I_2=0}, \quad A_{22} = \frac{I_1}{I_2} \bigg|_{V_2=0}$$

$$H_{11} = \left. \frac{V_1}{I_1} \right|_{V_2=0}, \quad H_{12} = \left. \frac{V_1}{V_2} \right|_{I_1=0}, \quad H_{21} = \left. \frac{I_2}{I_1} \right|_{V_2=0}, \quad H_{22} = \left. \frac{I_2}{V_2} \right|_{I_1=0}$$







$$\begin{cases} V_1 = Z_{11}I_1 + Z_{12}I_2 \\ V_2 = Z_{21}I_1 + Z_{22}I_2 \end{cases}$$



$$Z_1 = V_1 / I_1 = j\omega L_1 \quad Z_2 = V_2 / I_2 = j\omega L_2$$



$$22 = 12/12, \quad 212 = 12/12$$



$$\begin{bmatrix} Y_{11} & Y_{12} \\ Y_{21} & Y_{22} \end{bmatrix} = \begin{bmatrix} Z_{11} & Z_{12} \\ Z_{21} & Z_{22} \end{bmatrix}^{-1} = \begin{bmatrix} j\omega L + 1/j\omega C & 1/j\omega C \\ 1/j\omega C & 1/j\omega \end{bmatrix}^{-1} = \begin{bmatrix} 1/j\omega L & -1/j\omega L \\ -1/j\omega L & j\omega C + 1/j\omega L \end{bmatrix}$$



$$\begin{bmatrix} a & b \\ c & d \end{bmatrix}^{-1} = \frac{1}{ad - bc} \begin{bmatrix} d & -b \\ -c & a \end{bmatrix}$$







$$\mathbf{Z} = \begin{bmatrix} Z_{11} & Z_{12} \\ Z_{21} & Z_{22} \end{bmatrix} = \begin{bmatrix} 4\Omega & j3\Omega \\ j3\Omega & 2\Omega \end{bmatrix}$$

W E 20







$$\begin{cases} V_1 = Z_{11}I_1 + Z_{12}I_2 = 4I_1 + j3I_2 \\ V_2 = Z_{21}I_1 + Z_{22}I_2 = j3I_1 + 2I_2 \end{cases}$$

$$\begin{cases} V_1 = V_0 - Z_0 I_1 = 3 - 5I_1 \\ V_2 = -Z_L I_2 = -4I_2 \end{cases}$$

$$\begin{cases} 9I_1 + j3I_2 = 3 \\ j3I_1 + 6I_2 = 0 \end{cases}$$

$$I_1 = \frac{2}{7},$$

$$I_2 = -\frac{2}{7}$$

$$v_1 = \frac{11}{7},$$

$$v_2 = \frac{24}{7}$$





WISDOM IS



11 + 23 = 54

$I_1$

$=$

$-$

$I_2$

$I_2$

2020-2021

$$Z_T = \frac{V_2}{I_2} = 3$$

$$\begin{cases} V_1 = Z_{11} I_1 = 4 I_1 \\ V_2 = Z_{21} I_1 = j3 I_1 \end{cases}$$

$$I_1 = \frac{V_0 - V_1}{20} = \frac{3 - 4}{5} I_1$$

11

11

11

11

11





$$V_2 = Z_{21} I_1 = j3 \frac{1}{3} = j$$

$$V_2 = \frac{V_T}{Z_T + Z_L}$$

$$Z_L = \frac{j4}{3 + j4} = \frac{j4}{7}$$

$$I_2 = -\frac{V_2}{Z_L} = -\frac{j4}{7} = -\frac{j}{7}$$



$$i_2 = \frac{V}{Z_1 + Z_2 Z_3 / (Z_2 + Z_3)} = V \frac{Z_3}{Z_1 Z_2 + Z_1 Z_3 + Z_2 Z_3}$$

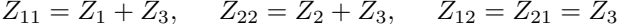
$$i_1 = \frac{V}{Z_2 + Z_1 Z_3 / (Z_1 + Z_3)} = V \frac{Z_3}{Z_1 Z_2 + Z_1 Z_3 + Z_2 Z_3}$$







$$\begin{cases} V_1 = (Z_1 + Z_3)I_1 + Z_3I_2 = Z_{11}I_1 + Z_{12}I_2 \\ V_2 = Z_3I_1 + (Z_2 + Z_3)I_2 = Z_{21}I_1 + Z_{22}I_2 \end{cases}$$



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$$\begin{cases} I_1 = Y_1 V_1 + Y_3 (V_1 - V_2) = (Y_1 + Y_3) V_1 - Y_3 V_2 = Y_{11} V_1 + Y_{12} V_2 \\ I_2 = Y_3 (V_2 - V_1) + Y_2 V_2 = -Y_3 V_1 + (Y_2 + Y_3) V_2 = Y_{21} V_1 + Y_{22} V_2 \end{cases}$$

$$Y_{11} = Y_{12} + Y_{13} \quad Y_{21} = Y_{22} + Y_{23}$$









$$Y_{15} + Y_{12} + Y_{22} + Y_{21} + Y_{13} + Y_{23}$$









$$\begin{bmatrix} V_1 \\ V_2 \end{bmatrix} = \begin{bmatrix} Z_{11} & Z_{12} \\ Z_{21} & Z_{22} \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} 1+j5 & 1 \\ 1 & 1-j5 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix}$$

$$\begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} 1+j5 & 1 \\ 1 & 1-j5 \end{bmatrix}^{-1} \begin{bmatrix} V_1 \\ V_2 \end{bmatrix} = \frac{1}{25} \begin{bmatrix} 1-j5 & -1 \\ -1 & 1+j5 \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \end{bmatrix} = \begin{bmatrix} Y_{11} & Y_{12} \\ Y_{21} & Y_{22} \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \end{bmatrix}$$

$$Y_1 = Y_1 + Y_2 = j/5, \quad Y_2 + Y_2 = j/5, \quad Y_3 = -Y_2 = 1/25$$



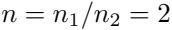


10

10

100





$$\begin{cases} V_1 = 10 I_1 + 2 V_2 \\ I_2 - V_2/5 = -2 I_1 \end{cases}$$

25101505

1101 + 1010

$$\begin{bmatrix} V_1 \\ V_2 \end{bmatrix} = \begin{bmatrix} Z_{11} & Z_{12} \\ Z_{21} & Z_{22} \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} 30 & 10 \\ 10 & 5 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix}$$



212

5

212

5

10

$$\begin{cases} I_1 = (V_1 - 2V_2)/10 \\ I_2 = -2I_1 + V_2/5 \end{cases}$$

15105

$$I_2 = V_1 + 2V_5 + V_2 + V_5 + 3V_2 + V_5$$

$$\begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} Y_{11} & Y_{12} \\ Y_{21} & Y_{22} \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \end{bmatrix} = \begin{bmatrix} 1/10 & -1/5 \\ -1/5 & 3/5 \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \end{bmatrix}$$



$$\mathbf{Z}^{-1} = \begin{bmatrix} 30 & 10 \\ 10 & 5 \end{bmatrix}^{-1} = \frac{1}{50} \begin{bmatrix} 5 & -10 \\ -10 & 30 \end{bmatrix} = \begin{bmatrix} 1/10 & -1/5 \\ -1/5 & 3/5 \end{bmatrix} = \mathbf{Y}$$







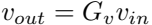












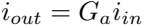


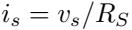


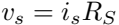














$$v_{in} = i_s (R_S \parallel r_{in}) = i_s \frac{R_S r_{in}}{R_S + r_{in}} = v_s \frac{r_{in}}{R_S + r_{in}}$$



$$v_{out} = G_v v_{in} \frac{R_L}{R_L + r_{out}} = G_{vi} \frac{R_S r_{in}}{R_S + r_{in}} \frac{R_L}{R_L + r_{out}} = G_v v_s \frac{r_{in}}{R_S + r_{in}} \frac{R_L}{R_L + r_{out}}$$



$$R_{in} = \frac{\text{voltage } v_{in} \text{ across the input port}}{\text{current } i_{in} \text{ through the input port}}$$

1994



$$R_{out} = \frac{\text{open-circuit voltage}}{\text{short-circuit current}} = \frac{v_{oc} = v_T \quad (R_L = \infty)}{i_{sc} = v_T / R_T \quad (R_L = 0)} = R_T$$







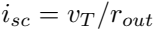




$$A_{oc} = \frac{\text{open-circuit voltage}}{\text{ideal voltage source}} = \frac{v_{oc}}{v_{in}}$$







$$R_{out} = \frac{v_{oc}}{i_{sc}} = \frac{r_{out} R_2}{r_{out} + R_2} = r_{out} || R_2$$

Practical  
= Power









$$V_{AB} = \frac{r_{in}}{R_1 + r_{in}}$$



$$A_{v_{in}} \frac{R_2}{r_{out} + R_2} = A_{V_{AB}} \frac{r_{in}}{R_1 + r_{in}} \frac{R_2}{r_{out} + R_2}$$



$$\frac{V_{CD}}{V_{AB}} = \frac{A R_2 r_{in}}{(R_1 + r_{in})(r_{out} + R_2)} \quad \xrightarrow{r_{in} \rightarrow \infty, r_{out} = 0} A$$





$$v_{in} = v_s \frac{r_{in}}{R_1 + r_{in}},$$

$$v_1 = v_s \frac{R_1}{R_1 + r_{in}}$$

$$v_{oc} = v_1 + Av_{in} = v_s \frac{R_1}{R_1 + r_{in}} + Av_s \frac{r_{in}}{R_1 + r_{in}} = v_s \frac{R_1 + Ar_{in}}{R_1 + r_{in}}$$

$$A_{oc} = \frac{v_{oc}}{v_s} = \frac{R_1 + A r_{in}}{R_1 + r_{in}} < A$$







vs  $\mathbb{R}^n$  +  $\mathbb{R}^n$  in  $\mathbb{R}^n$



$$A_n = A_n + B_n$$

$$i_{sc} = v_s \frac{Ar_{in} + R_1}{(1-A)R_1r_{in} + r_{out}(R_S + r_{in} + R_1) + R_S R_1}$$

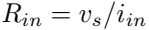
$$v_{oc} = A r_{in} i_{in} + R_1 i_{in} = (A r_{in} + R_1) \frac{v_s}{R_s + r_{in} + R_1}$$

$$R_{out} = \frac{v_{oc}}{i_{sc}} = \frac{(1-A)r_{in}R_1 + r_{out}(R_S + r_{in} + R_1) + R_S R_1}{R_S + r_{in} + R_1} = r_{out} + \frac{(1-A)r_{in}R_1 + R_S R_1}{R_1 + r_{in} + R_S}$$



$$R_{out} \stackrel{R_S=0}{=} r_{out} (A-1) r_{in} || R_1 || r_{out}$$







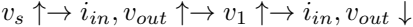
A pixelated, black and white graphic of the text "v9 + R1 v9 + R1". The text is rendered in a stylized, blocky font with a dithered or pixelated appearance. The characters are composed of various shades of gray and black pixels. The plus signs are also pixelated. The overall style is reminiscent of early digital art or low-resolution computer graphics.

$$A_{\text{in}} = A_{\text{in}}^{\text{out}} + P_{\text{in}}^{\text{out}} - P_{\text{in}}$$

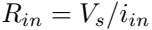
$$v_{in} = v_s \frac{R_1 + R_L + r_{out}}{(R_L + r_{out})(R_1 + r_{in}) + (1 - A)R_1 r_{in}} \xrightarrow{R_L \rightarrow \infty} \frac{v_s}{r_{in} + R_1}$$

$$R_{in} = \frac{v_s}{i_{in}} = \frac{(R_L + r_{out})(R_1 + r_{in}) + (1 - A)R_1 r_{in}}{R_1 + R_L + r_{out}} \xrightarrow{R_L \rightarrow \infty} R_1 + r_{in} > r_{in}$$













How does it work?









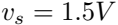








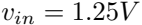




19

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500



15

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1500



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