Statement of Problem 4.4-7 page 145

$$MTX\left(V_S, K_{IV}, K_{VV}, R_A, R_B, R_D\right) := \begin{pmatrix} -1 & \frac{K_{IV}}{R_B} + 1 & 0 & 0 & 0 \\ K_{VV} & -1 - \frac{K_{IV}}{R_B} & 0 & 0 & 0 \\ \frac{-1}{R_A} & 0 & 1 & 1 & 0 \\ \frac{1}{R_A} & \frac{1}{R_B} & 0 & 0 & -1 \\ 0 & \frac{-1}{R_B} - \frac{1}{R_D} & 0 & -1 & 0 \end{pmatrix} \begin{matrix} \text{Loop 2} \\ \text{Loop 3} \\ \text{Node 1} \\ \text{Node 2} \\ \text{Node 3} \end{matrix}$$

Vector-Matrix solution of problem

$$VectS\left(V_S, K_{IV}, K_{VV}, R_A, R_B, R_D\right) := MTX\left(V_S, K_{IV}, K_{VV}, R_A, R_B, R_D\right)^{-1} \cdot \begin{bmatrix} -\frac{K_{IV}}{R_B} \cdot V_S \\ \left(\frac{K_{IV}}{R_B} - K_{VV}\right) \cdot V_S \\ \frac{V_S}{R_A} \\ -\left(\frac{1}{R_A} + \frac{1}{R_B}\right) \cdot V_S \\ \frac{V_S}{R_B} \end{bmatrix}$$

Functional extraction of each unknown from the vector solution (inefficient but simple)

$$VS_1(V_S, K_{IV}, K_{VV}, R_A, R_B, R_D) := VectS(V_S, K_{IV}, K_{VV}, R_A, R_B, R_D)_0$$

$$VS_3(V_S, K_{IV}, K_{VV}, R_A, R_B, R_D) := VectS(V_S, K_{IV}, K_{VV}, R_A, R_B, R_D)_1$$

$$IVVS(V_S, K_{IV}, K_{VV}, R_A, R_B, R_D) := VectS(V_S, K_{IV}, K_{VV}, R_A, R_B, R_D)_2$$

$$IIVS(V_S, K_{IV}, K_{VV}, R_A, R_B, R_D) := VectS(V_S, K_{IV}, K_{VV}, R_A, R_B, R_D)_3$$

$$ICS(V_S, K_{IV}, K_{VV}, R_A, R_B, R_D) := VectS(V_S, K_{IV}, K_{VV}, R_A, R_B, R_D)_4$$

The known paramters as stated in Problem 4.4-7 page 145

$V_S := -15$ $K_{IV} := 10$ $K_{VV} := 4$ $R_A := 10$ $R_B := 20$ $R_D := 5$ New values

$V_S := -10$ $K_{IV} := 8$ $K_{VV} := 3$ $R_A := 2$ $R_B := 8$ $R_D := 4$ Problem statement

Place active ones here

First, check the determinant to make sure that we don't have a redudnant equation or trick problem.

$$\left|MTX(V_S, K_{IV}, K_{VV}, R_A, R_B, R_D)\right| = 4$$

Store the output in scalar variables

$V_1 := VS_1(V_S, K_{IV}, K_{VV}, R_A, R_B, R_D)$ $V_3 := VS_3(V_S, K_{IV}, K_{VV}, R_A, R_B, R_D)$

$I_{VV} := IVVS(V_S, K_{IV}, K_{VV}, R_A, R_B, R_D)$ $I_{IV} := IIVS(V_S, K_{IV}, K_{VV}, R_A, R_B, R_D)$

$I_C := ICS(V_S, K_{IV}, K_{VV}, R_A, R_B, R_D)$

Compute all the other parameters for the solution from the outputs

$V_B := V_3 + V_S$ $V_A := V_1 + V_S$ $V_2 := -V_S$ $V_D := V_3$

$$I_A := \frac{V_A}{R_A} \qquad I_B := \frac{V_B}{R_B} \qquad I_D := \frac{V_D}{R_D}$$

Give the solution numerically

$V_A = 5$ $V_B = 2.5$ $V_D = 12.5$

$I_A = 2.5$ $I_B = 0.312$ $I_D = 3.125$

$V_1 = 15$ $V_2 = 10$ $V_3 = 12.5$

$I_{VV} = 5.937$ $I_{IV} = -3.437$ $I_C = 2.813$

Checks

Loop 1: $V_B - V_D - V_S = 0$

Loop 2: $K_{IV} \cdot I_B + V_B - V_A = 0$

Loop 3: $-V_D - K_{IV} \cdot I_B + K_{VV} \cdot V_A = -7.105 \times 10^{-15}$

Node 1: $I_{VV} + I_{IV} - I_A = 0$

Node 2: $I_A + I_B - I_C = -1.776 \times 10^{-15}$

Node 3: $-I_{IV} - I_B - I_D = 0$