Y parameters

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Objectives:

1. Implement Y parameters
2. Generate Y parameters from TL model.
3. Code Y parameters with different frequencies.
4. Final FYP report

Let’s consider the following example to code this in MATLAB, assume the rational approximation for (denominators must match):

So,

To make it proper (numerator degree < denominator degree) we can say:

To make this proper we can use the following method:

If deg(N) deg(D), perform polynomial division:

Then the proper form is:

Where deg(R) < deg(D). In MATLAB, this can easily be implemented as follows using deconvolution

clear all

clc

N = [-2 -3];% Define the numerator coeff

D = [1 6]; % Define the den coeff

[Q,R]=deconv(N,D);% Perform polynomial division

R = tf(R,D);

Then, the state space model is as follows:

Then, AWE can be implemented to get the response and compare it to the actual one.

The following code will generate state space representation with Y21 and Y22:

clear all

clc

% Define numerator coefficients of Y21 and Y22, and common denominator

num\_Y21 = [2 3];

num\_Y22 = [1 6];

den = [1 4 5];

N = -num\_Y21;

D = num\_Y22;

% Perform polynomial division to make it strictly proper

[Q, R] = deconv(N, D);

% check leading coefficient (assumed to be 1)

if D(1) ~= 1

D=D/D(1);

N = N/D(1);

[Q, R] = deconv(N, D);

end

% Extract coefficients for state-space representation

g = D(2:end); % Exclude leading coefficient ( g terms )

% f terms

if R(1) ==0

f=R(2:end);

else

f = R;

end

% Construct state-space matrices

n = length(g); % Order of system

A = [zeros(n-1,1), eye(n-1); -flip(g)];

B = [zeros(n-1,1); 1];

C = flip(f);

D = Q;

* Generate Y parameters from TL model and compare it to the actual one.

A diagram of a parallel diagram

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From the exact solution, we can say that:

From the Y parameters if :

Where,

So,

At s=iw

Let’s plot this at different values for using the following code in MATLAB:

clear

clc

l = 400;

R = 0.01;

L = 2.5e-7;

C = 1e-10;

G=0;

f=0:1:5000;

w = 2\*pi\*f;

s=1i\*w;

Z = (R+s\*L);

Y = G+s\*C;

Zo = sqrt(Z./Y);

gama = sqrt(Z.\*Y);

Y11= cosh(gama .\* l)./(Zo.\*sinh(gama\*l));

|  |  |
| --- | --- |
|  |  |
|  | 0.25 - 0.0000i |
|  | 0.2500 - 0.0020i |
|  | 0.2485 - 0.0195i |
|  | 0.2166 - 0.0848i |
|  | 0.1546 - 0.1210i |

* Generate Y parameters out of these values:

Consider n=2:

At

Re-write this as:

To find the coefficients we can use the following:

Say B matrix contains the coefficients as follows:

So,

Where N is the number of data points (i.e w). the first 2 rows are repeated depending on how many data points we are considering.

For example, let’s say we are considering the last 3 points from the table above, then A will have 4 by 6 rows (2\*N).

In MATLAB:

clear all

clc

% Given the last 3 points

Yr = [0.2485, 0.2166, 0.1546]; % Real part of Y11

Yi = [-0.0195, -0.0848, -0.1210]; % Imaginary part of Y11

w = [1000\*pi, 5000\*pi, 10000\*pi];

A = [];

C = [];

% Loop through each frequency point to construct A and C

for k = 1:length(w)

wk = w(k);

Yr\_k = Yr(k);

Yi\_k = Yi(k);

% Construct rows for A and C

A\_row1 = [-1, Yr\_k, 0, -wk\*Yi\_k]; % Real part

A\_row2 = [0, Yi\_k, -wk, wk\*Yr\_k]; % Imaginary part

% Append to A

A = [A; A\_row1; A\_row2];

% C

C\_row1 = wk^2 \* Yr\_k; % Real part

C\_row2 = wk^2 \* Yi\_k; % Imaginary part

% Append to C

C = [C; C\_row1; C\_row2];

end

% Solve for B = [a0; b0; a1; b1]

B = A \ C;

% get cof

a0 = B(1);

b0 = B(2);

a1 = B(3);

b1 = B(4);

f = 0:100:10000;

w = 2\*pi\*f;

s = i\*w;

% generated H

H = (a1\*s+a0)./(s.^2+b1\*s+b0);

l = 400;

R = 0.01;

L = 2.5e-7;

C = 1e-10;

G=0;

Z = (R+s.\*L);

Y = G+s.\*C;

Zo = sqrt(Z./Y);

gama = sqrt(Z.\*Y);

Y11= cosh(gama.\* l)./(Zo.\*sinh(gama.\*l));

% find the error

n =length(H)-1;

Error = abs(H-Y11);

Error = Error(2:end);

Error = sum(Error)/n;

% plot both in the same figure

figure(1)

plot(f,H,f,Y11,'r \*');

legend('generated Y' ,'Exact Y')

grid on

The following figure shows the generated Y parameter compared to the exact one with Mean Absolute Error of 9.3115e-05.

A graph with red dots

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