Implement AWE

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AWE involves 4 main steps:

1. Form a state – space representation

2. Form the moments

3. Find the poles of the system

4. Find the residues

And then form the impulse response as:

(1)

The following code implements AWE with first and second approximation:

1. clear all

2. clc

3. A = [-2 1 0 0;1 -2 1 0;0 1 -2 1;0 0 1 -1];

4. B = [1;0;0;0];

5. C = [1;0;0;0];

6. q = length(B);

7. moments = zeros(1,2\*q-1);

8. for i=1:length(moments)

9. moments(i) = -1\*transpose(C)\*A^-i\*B;

10. end

11. %for first order approximation (Case 1)

12. b = -moments(2)/moments(1);

13. %the poles

14. p = -1/b;

15. % residues

16. k=-moments(1)\*p;

17. %t = 0:0.01:0.5

18. %hense

19. ht1 = k\*exp(p\*t);

20. %Case 2

21. m2 = [moments(1),moments(2);moments(2),moments(3)];

22. m2\_2 = -1\*[moments(3);moments(4)];

23. b\_case2 = inv(m2)\*m2\_2;

24. p\_case2 = roots([b\_case2(1),b\_case2(2),1]);

25. %residues

26. V = [1 1 ;1/p\_case2(1) 1/p\_case2(2)];

27. A\_case2 = [1/p\_case2(1) 0;0 1/p\_case2(2)];

28. k\_case2 = -1\* inv(A\_case2) \* inv(V) \* [moments(1);moments(2)];

29. % hence the final expersion is

30. ht\_case2 = k\_case2(1)\*exp(p\_case2(1)\*t)+k\_case2(2)\*exp(p\_case2(2)\*t);

31.

This code takes the input as matrices A,B and C. For example let :

(2)

First one must find the moments as follows:

Where (i) goes from 0 to 2q-1 and q is the order of the transfer function associated with the equation or the state space.

In example 1 we can find that,

Next, find b (coefficients of s in the Laplace expression) as follows:

Then solve for B(s)=0 to obtain the poles of the system where:

Next, finding the residues as:

So, back to example 1, since q = 4, we can find that for a first order approximation:

Hence using the general expression in (1) we obtain,

in the same manner we can then find second, third and fourth order approximations.

Now, Let’s consider the following circuit:

A diagram of a circuit

Description automatically generated