**Two synchronous generators – Using reduced model instead of full model.**

In this paper, we will try to investigate a model reduction for the two generators system.

**The full model:**

As we showed, a model for two generators is:

Where:

,

**The reduced model:**

We can write the model in the following way:

Where

, ,

We assume that is very small which means that is much faster than, so it get to it equilibrium point (which we assume that exist, and attractive throw all paths of ) almost instantly with comparing to .

So we will calculate the root of (it is linear system)

and we will use it in order to solve the three order system:

Although this system is only 3rd order system, this nonlinear system is very complex. In order to simplify the dynamic of the reduced model, we will substitute also at the right hand side of and we will show the dynamic for . [See Khalil Non Linear Systems 3rd edition pages 423 – 460].

And now

**Specific case: Almost 10 KW generator parameters.**

Let's examinant case of 10 KW generator parameters, where we will replace the 10 KW inductor value ( 2.2 [mH]) with 0.1 [mH] inductor.

The system parameters:

First, let's find the system equilibrium points:

As we showed, the system equilibrium points must satisfy:

**1. We will start with:**

We will find with the cubic equation from page 12 at the notes:

Where

Solving this equation give the following solution:

The only real solution gives

We will calculate with the dynamics of the third line:

We will calculate with the dynamics of the second line:

In order to validate those results, let's calculate

This is MATLAB numerical error.

**2. Now, :**

We will get the same results as at the previous section, but with

Solving:

Gives:

Now,

In order to validate those results, let's calculate

This is MATLAB numerical error.

Now we will calculate the Jacobian of this system:

Where:

We will substitute our parameters and our equilibrium points into and calculate (numerically) its eigenvalues:

**For :**

We get:

This shows that this equilibrium point is not stable.

**For :**

We get:

This shows that this equilibrium point is not stable.

**The reduced model:**

Let's validate that the equilibrium point which we found (for ) is also equilibrium point for the reduced model.

This is very small number, but it is not small as the value which we got for the full model , because we neglect the inductors when we calculate the equilibrium point of the fast dynamics.

Now, in order to investigate the stability of the system we will calculate the Jacobian of this system, at the equilibrium point:

It's easy to see that at the equilibrium point, the third column will be zero, so we will have zero eigenvalue, which means that our reduction is not clear enough.

**More accurate model:**

In order to have more accurate reduction, let's neglect factors with , but we will still have factors with :

And now:

We will substitute the equilibrium point and calculate the eigenvalue:

It shows that although the system is not stable, the model reduction is stable.

We will show simulation of system with these parameters set which starts from arbitrary initial point:

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