**Euler’s method**

$$ x\left(t+Δt\right)=x\left(t\right)+Δt⋅f\left(x\right)$$

Where $f\left(x\right)=\dot{x}$

 $ \dot{δ} =ω$

 $\frac{2H}{ω\_{s}}\dot{ω}=T\_{M}-\frac{E^{'}V\_{s}}{X\_{d}^{'}+X\_{ep}}\sin(\left(δ-θ\_{vs}\right))-D⋅ω$

A 60 Hz generator is supplying 200 MW and 0 Mvar to an infinite bus (with 1.0 per-unit) through two parallel transmission lines. Each transmission line has a per-unit impedance (with 100 MVA base) of j0.04. The per-unit transient reactance for the machine is j0.03, and its inertia constant is 10 seconds. A fault occurs at time = 0 halfway down one of the lines.

1. Rewrite the equations above with the only remaining variables: $δ$, $ω$, $E'$, $T\_{M}$, $V\_{s} $and $X\_{ep}$.
2. Draw a circuit diagram of the system (a) before the fault and (b) during the fault. Use this to calculate the Thevenin equivalent impedance $X\_{ep}$ for each condition.
3. The pre-fault condition is in steady-state. Calculate the internal voltage, which will be equal to $E^{'}∠δ$. What are the constant values of $E'$ and $T\_{M}$, and the initial values of the variables $δ$ and $ω$?
4. Use Euler’s method with a time step of $Δt=0.01$ seconds, find the value of $δ$ and $ω$ at $t=0.01$ and $t=0.02$.

Homework

More practice for Euler’s method: calculate the first three time steps of each initial value problem.

1.

$$3\dot{x}=2x^{2}-x$$

$$x\left(0\right)=-1$$

2.

$$\dot{x}=-5y+3$$

$$\dot{y}=-x$$

$$x\left(0\right)=y\left(0\right)=0$$

3.

Use the swing equation above:

A 60 Hz generator is supplying 150 MW and 0 Mvar to an infinite bus (with 1.0 per-unit) through two parallel transmission lines. The per-unit transient reactance for the machine is j0.01, and its inertia constant is 4 seconds. Each transmission line has a per-unit impedance (with 100 MVA base) of j0.06. A fault occurs at time = 0 one-third of the way down one of the lines, closer to the generator than the infinite bus.