Lab 5: Electromagnetic Transients

ECE 433 – Power Systems Stability and Transients

# Postlab

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| **Name** | **Student ID** | **CCID** | **Lab Section** |
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## Graphs

G1. Run a Sample Case – Fault at 0.01667 s

<insert plot here>

G1. Run a Sample Case – Fault at 0.02084 s

<insert plot here>

G2. Capacitor Energization – Initial conditions

<insert plot here>

G3. Capacitor Energization – Vs – 0 Ω

<insert plot here>

G4. Capacitor Energization – Breaker time = 0.02084s

<insert plot here>

G5. Capacitor Energization – Capacitor pre-charge = 28.17 kV

<insert plot here>

G6. Back-to-back Capacitor Energization – Vs, Vcap1, Vcap2

<insert plot here>

G7. Back-to-back Capacitor Energization – Is, Icap1, Icap2

<insert plot here>

## Questions

#### Run a Sample Case

Q1. Looking at only the first case with a closing time of 0.01667 s, explain what is happening in the simulation before and after the fault.

Q2. Explain why a breaker with a different closing time in the simulation would cause the resulting waveform to look different. Are there any potential problems because of this?

#### Build a New Case – Capacitor Energization

Q3. For the plots obtained with the initial simulation conditions explain the behavior of waveforms before and after capacitor switching.

Q4. For the plots obtained with a AC source resistance of zero ohms, explain the difference in behavior of the waveforms compared to those with the initial simulation conditions.

Q5. For the plots obtained with the modified fault time of 0.02084 seconds, explain the difference in behavior of the waveforms compared to those with the initial simulation conditions.

Q6. Make the following measurements from the 2 separate scenarios when the breaker time is set to 0.02084 seconds. Note that these 2 different scenarios have the capacitor initially pre-charged to different values (0 kV and 28.17 kV).

1. The steady-state peak current of capacitor.
2. The highest transient peak current of capacitor.
3. The steady-state peak voltage of capacitor.
4. The highest transient peak voltage of capacitor.

* *Hint: in order to get the right steady state waveforms extend the simulation period to 0.5 sec.*

Explain what the impact of pre-charged voltage of the capacitor has on the maximum transient current? Use yours measured results to back up your answer.

#### Back-to-back Capacitor Energization

Q7. Explain the behavior of the Vs, Vcap1, and Vcap2 waveforms before and after the switching of the second capacitor.

Q8. Explain the behavior of the Is, Icap1, and Icap2 waveforms before and after the switching of the second capacitor. Why are the peak current magnitudes of Icap1 and Icap2 so much larger than that of Is?

Q9. Go to the “*Project”* ribbon and change “*Solution Time Step”* from 5 us to 100 us and run the simulation again. What is the impact of solution time step on the results? You may need to zoom in on the plots during the transient to see the change of results clearly.