Dept. Electrical and Computer Engineering
The University of British Columbia
EECE560 Network Analysis and Simulation January 2021
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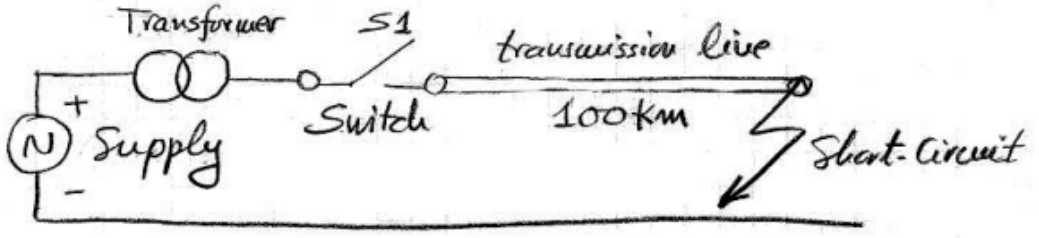
# ASSIGNMENT No. 2

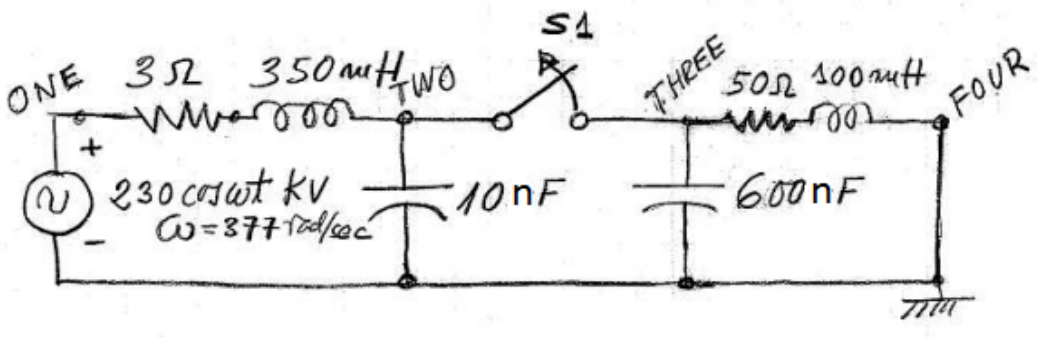
Due Date: 5 February 2021

## Transient Recovery Voltage (TRV) in Circuit Breakers using a Lumped-Circuit Line Model

A short-circuit occurs in a transmission line at some distance from the supply. The circuit breaker (switch) will act to interrupt the current.




An important parameter in designing the system is the voltage across the breaker after interrupting the short circuit (Transient Recovery Voltage TRV). The circuit breaker is connecting two subcircuits with different natural frequencies of oscillation. The system is represented using the equivalent circuit below. On the left hand side of the breaker, we have the source voltage and a resistance and inductance that represent the impedance of the system supplying the transformer plus the impedance of the transformer. The capacitor at node two on the left of the breaker represents the combined substation capacitance. On the right of the breaker we have the transmission line parameters: total resistance, total inductance and total capacitance represented as a pi-circuit with the right-leg capacitor shorted by the fault.




In this assignment you will write your own computer program using nodal analysis to solve the system and will compare the results of your program with those obtained using PSCAD.

1. Assume the system is operating with zero initial conditions and with switch $S_1$ initially closed.

2. The short circuit occurs at $t = 0$.

3. Suppose the breaker $S_1$ is designed to open 4 cycles (66.67 ms) after the fault occurs. However, because the breaker cannot chop current, it will not actually open (by operational design) until the current through it crosses zero.

4. Take a simulation time span from $t = 0$ to $t = 200\,\text{ms}$.

5. Choose an appropriate $\Delta t$ according to the time constants of the circuit. For this purpose, evaluate the approximate resonant frequencies (you can neglect the resistances) of the circuits on the left and right sides of the breaker with the switch open, and of the combined circuit with the switch closed.

Plot the following graphs, including a zoomed-in region of some ms before opening the breaker and the transients created by this operation.

1. Plot $v(one)$, $v(two)$, $v(three)$ on the same graph for your program and for PSCAD.

2. Plot $i(four, ground)$ on the same graph for your program and for PSCAD.

3. Plot $v(two, three)$ on the same graph for your program and for PSCAD.

4. Analyze the results and make relevant comments.

5. Is the fact that the two circuits joined by the breaker have different resonant frequencies of relevance?