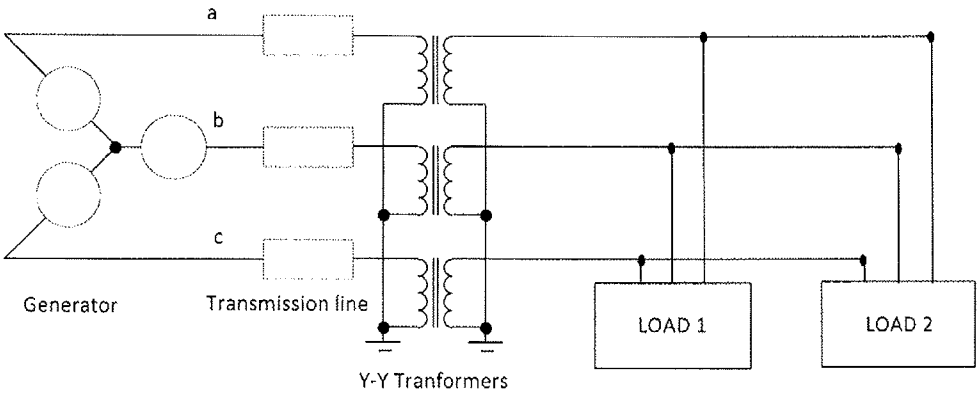
9A Power Systems (2.0 points)

In the figure below you are given a balanced three phase network with a generator, a transmission line, a set of transformers and two balanced three phase loads.



The three phase power drawn by the loads:

LOAD 1 is 100 kVA at 0.8 power factor lagging

LOAD 2 is 120 kW at .96 power factor leading.

The magnitude of the Line to Line voltage at the loads is 440 volts.

The transformers are connected in a Y-Y connection. Each transformer's turns ratio is 10:1 and the low voltage side is connected to the loads.

The transmission line impedance is 2+4j ohms in each phase.

Find the Line to Line voltage at the generator terminals. (Note that for this problem we have assumed that there is no generator internal impedance - just the voltage sources).

9B (Power Electronics)

In a balanced three-phase dc-ac inverter, the phase-*a* average output voltage, with respect to the load-neutral "n", is $\bar{v}_{an}(t) = 112.5\sin(\omega_1 t)$, where the dc-bus voltage $V_d = 300V$ and $\omega_1 = 2\pi \times 45 rad/s$. The wye-connected load on the ac-side can be represented in each phase, for example in phase-a, by an internal voltage $e_a(t) = 106.14\sin(\omega_1 t - 6.6^0)V$ in series with an inductance L of 5 mH. Assume that this inverter is sine-PWM controlled and the switching frequency is several orders of magnitude higher than the output frequency. Note: The "average" refers to the averaging over a switching time-period, in order to eliminate the switching components from the averaged quantities.

(a) Calculate and plot the pole duty-ratios $d_a(t)$, $d_b(t)$, and $d_c(t)$. (0.5 points)

(b) Sketch the average quantities associated with phase-a: $\bar{v}_{an}(t)$, $\bar{i}_a(t)$ and $\bar{i}_{da}(t)$, where $\bar{i}_a(t)$ is the average current into phase-a of the load, and $\bar{i}_{da}(t)$ is the average current drawn by pole-a from the dc bus. (1.0 points)

(c) Calculate and plot $\bar{i}_d(t)$, which is the average dc current drawn from the dc-bus of the inverter. (0.5 points)