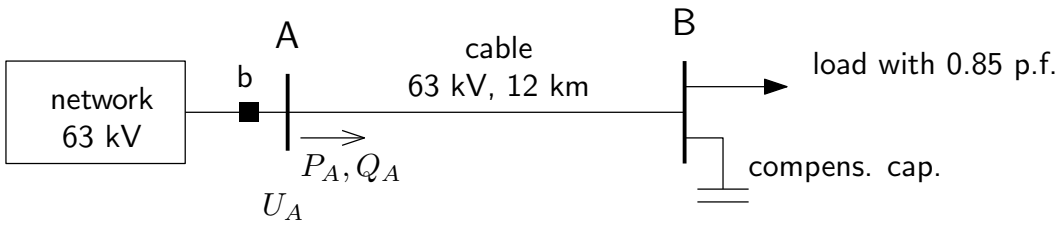
Examination of course ELEC0014 - January 12, 2018

Second part. Exercises

Exercise No 1

A load is fed by a network through a cable with nominal voltage 63 kV, as shown below.



The per length unit parameters of the cable are : resistance $r = 0.15$ Ω/km, reactance $x = 0.20$ Ω/km, half shunt susceptance $\omega c/2 = 40$ μS/km. The cable is 12 km long.

The load has a 0.85 power factor. The latter is partially improved by a compensation shunt capacitor.

The network (alone, i.e. without the cable, the load and the capacitor) has a short-circuit capacity of 400 MVA.

The operating point is specified at the sending end of the cable : voltage $U_A = 64$ kV, active power flow $P_A = 50$ MW, reactive power flow $Q_A = 20$ Mvar.

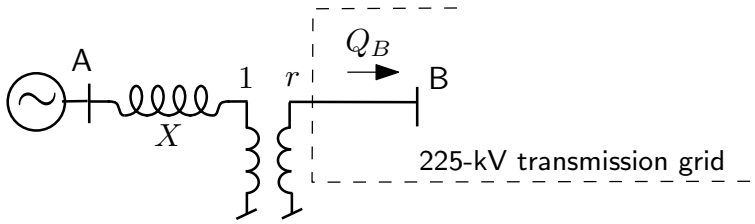
1. Which reactive power (in Mvar) is produced by the compensation capacitor ?
   Answer : 8.12 *Mvar.*
2. The compensation capacitor is made up of three capacitors connected in triangle. What is the capacitance of each of them, in μF ?
3. If the cable was tripped, what would be the new voltage at bus A (in kV) ?
4. If a three-phase short-circuit without impedance took place at bus A, which current (in A) would flow in (each phase of) the circuit breaker b ?

*Perform all computations in per unit on the base (*63 *kV,* 100 *MVA), before converting to the specified units.*

Exercise No 2 on reverse side !

Exercise No 2

A synchronous generator feeds a 225-kV transmission grid through a transformer modeled as shown in the figure below.



The generator has a nominal voltage of 20 kV and a nominal apparent power of 400 MVA. The stator resistance is neglected. Under the nominal voltage, the capability curves relative to the stator limit, the rotor limit and the turbine nominal power, respectively, cross each other at the same point.

The turbine has a nominal power of 360 MW.

The transformer has a nominal apparent power of 400 MVA, a primary nominal voltage of 20 kV, and a secondary nominal voltage of 237 kV. The factory tests give the following information:

- open-circuit test : voltage applied to primary side = nominal voltage (20 kV), voltage measured at the opened secondary side = nominal voltage (237 kV);
- short-circuit test : secondary side short-circuited and carrying its nominal current, voltage applied to primary = 3.2 kV.

Consider the following operating point: generator operating under its nominal voltage, turbine producing its nominal power, reactive power received by the network (at bus B) : $Q_B = 40$ Mvar.

Perform all computations in per unit on the bases (20 *kV,* 100 *MVA) and (*225 *kV,* 100 *MVA), respectively, before converting to the specified units.*

1. Show that the transformer parameters are $X = 0.04$ pu and $r = 1.0533$ pu/pu, on the above bases.
2. Compute the voltage at bus B, in kV.
3. Compute the reactive power produced by the generator, in Mvar.
4. Show that the generator operates inside the limits given by the capability curves.