Pertti Pakonen   Programmable calculator allowed   4 questions/ á 6 p

1. In what ways can the following terms be defined? Explain the differences between the definitions:
   a) Reactive power
   b) Total harmonic distortion
   c) Power factor

2. a) Why shunt-connected active power filter (APF) is connected close to the industrial load? What are hybrid active filters and what advantages do they have?

   b) What are resonances in electric power networks? What happens and why when a resonance occurs? What does resonance frequency mean and why is it relevant?

3. In what various ways are standards related to power quality and the management of disturbances in electric power networks. Give examples of how the standards may be applied in practice and what benefits may be achieved by them.

4. Consider a three-phase four wire unbalanced star-connected load ($Z_a = 2.0 + j0.5$ pu, $Z_b = 3.0 + j1.0$ pu and $Z_c = 4.0 + j1.5$ pu) having an input line-to-line voltage of 690 V, 50 Hz, three-phase AC supply. Base impedance is 1.25 Ω. The load should be compensated to draw only balanced active power from the AC supply using STATCOM described in the figure below. Additionally, the STATCOM should compensate the neutral current of the load to zero.
   The supply can be assumed stiff enough that the load has no effect on the voltage level.

   Calculate when the STATCOM is operating
   a) load and supply phase currents and load neutral current
   b) STATCOM phase currents and neutral current
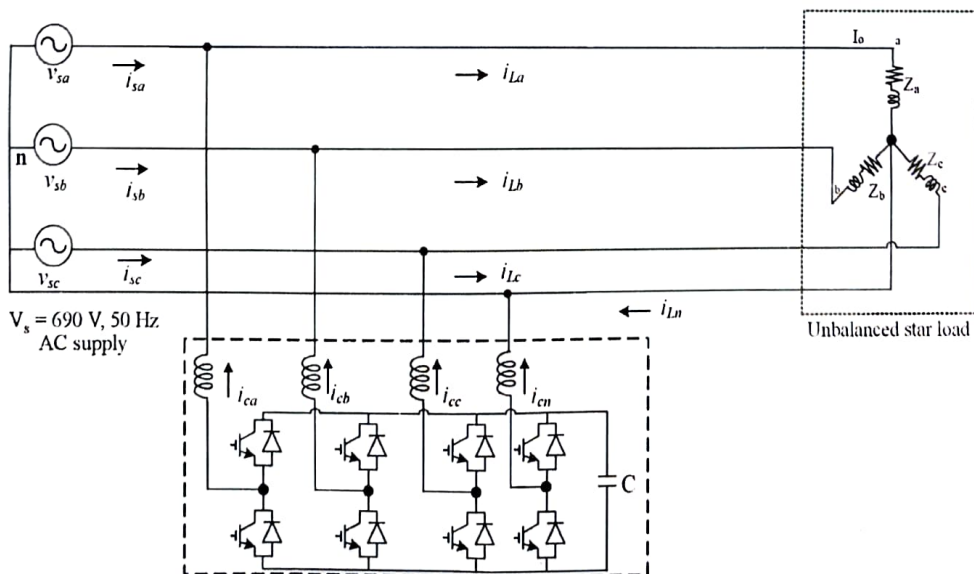   c) kVA rating of the STATCOM.

Fig. 1. Three-Phase STATCOM for compensation of unbalanced star connected load.