Problem 1: Space-vector components from line-to-line voltages

Line-to-line voltages u_{ab} and u_{bc} are known. Calculate u_α and u_β.

Problem 2: Inverse transformation

The inverse space-vector transformations are

$$u_{\mathrm{a}} = \mathrm{Re}\left\{\boldsymbol{u}_{\mathrm{s}}^{\mathrm{s}}\right\} \qquad u_{\mathrm{b}} = \mathrm{Re}\left\{\boldsymbol{u}_{\mathrm{s}}^{\mathrm{s}}\mathrm{e}^{-\mathrm{j}2\pi/3}\right\} \qquad u_{\mathrm{c}} = \mathrm{Re}\left\{\boldsymbol{u}_{\mathrm{s}}^{\mathrm{s}}\mathrm{e}^{-\mathrm{j}4\pi/3}\right\}$$

Let us consider the phase b as an example here. Show that the above expression for the phase voltage u_{b} holds.

Problem 3: Field weakening

Consider a three-phase four-pole permanent-magnet synchronous motor. The stator inductance is $L_{\mathrm{s}} = 0.035$ H and the stator resistance can be assumed to be zero. The permanent magnets induce the rated voltage of 400 V at the rotational speed of 1 500 r/min. The rated current is 7.3 A.

(a) The control principle $i_{\mathrm{d}} = 0$ is used. The motor is operated at the rated voltage and current. Calculate the rotational speed, torque, and mechanical power.

(b) The motor is driven in the field-weakening region at the rated voltage and current. The speed is increased until the absolute values of i_{d} and i_{q} are equal. Calculate the rotational speed, torque, and mechanical power.

Draw also the vector diagrams.