

**Problem 1: Characteristics of an interior-permanent-magnet motor**

The data of an interior-permanent-magnet motor is:

rated voltage	$U_N = 400 \text{ V}$	direct-axis inductance	$L_d = 0.06 \text{ H}$
rated current	$I_N = 10 \text{ A}$	quadrature-axis inductance	$L_q = 0.10 \text{ H}$
pole pairs	$p = 2$	permanent-magnet flux	$\psi_f = 1 \text{ Vs}$

The stator resistance is omitted. Draw the following characteristics in the  $i_d$ - $i_q$  plane:

- (a) constant current  $i_s = \sqrt{2}I_N$  (rated value);
- (b) constant torque of 30 Nm;
- (c) constant stator flux  $\psi_s = 1 \text{ Vs}$ .

**Problem 2: Current-minimizing control characteristics**

Consider the interior-permanent-magnet motor in the preceding problem.

- (a) Derive expressions for the current components  $i_d$  and  $i_q$ , when the stator current is constant and the torque is maximized.
- (b) Calculate the maximum torque at the rated current.
- (c) Calculate the rotational base speed corresponding to the rated voltage for the current and torque obtained above.
- (d) Calculate the displacement power factor  $\cos \varphi$  and draw a vector diagram for the operating point obtained above.