Exercise 9: Permanent Magnet DC Motor

Consider a permanent magnet DC motor for a working machine with the following data:

- rated power $P_n = 24,8\,\mathrm{kW}$
- rated torque $T_n = 69,6\,\mathrm{Nm}$
- rated current $I_{A,n} = 64,4\,\mathrm{A}$
- armature resistor $R_A = 0,188\,\Omega$ at $\vartheta = 125\,^\circ\mathrm{C}$
- inertia torque (with working machine) $J = 1,12\,\mathrm{kgm}^2$

The motor will be operated at the rated voltage with no load. The armature inductance and the voltage drop across the carbon brush are ignored.

The maximum permissible armature current is $I_{\mathrm{A,max}} = 190\,\mathrm{A}$.

a) Calculate the required series resistor R_v for starting the motor from standstill.

b) At what speed can the resistor be bridged?

c) Calculate and plot the speed curve $n(t)$. After which time t_B the series resistor can be bridged?

d) Plot the process of armature current i_A

e) After which time t_n of the motor reaches its rated speed?

The motor now start with an adjustable voltage source with no load.

f) Design an appropriate voltage profile $u_A(t)$, so that the motor starts in the shortest time until reaching its rated speed.

g) After which time $t_{\tilde{n}}$, the motor has reached its rated speed?