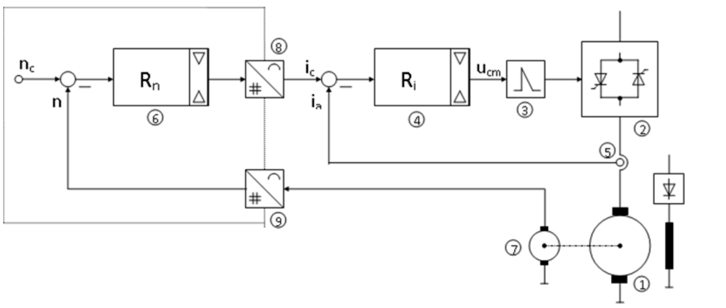
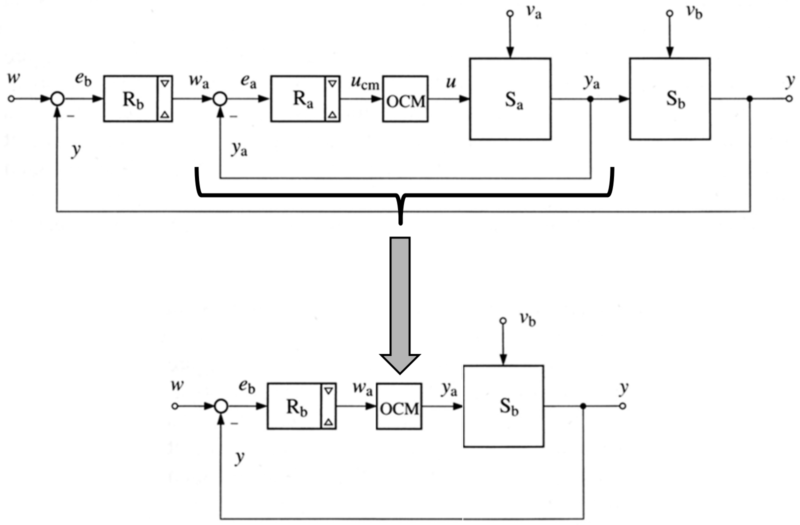
SPEED CONTROL OF A DC MOTOR

Principle of the speed control

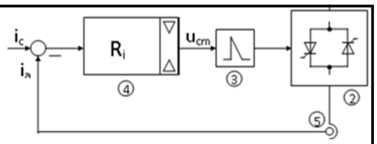


1. Anchor circuit of the motor
2. Converter
3. Gate-control circuit
4. Current controller
5. Current measurement device
6. Speed controller
7. Speed measurement device
8. D/A converter
9. A/D converter

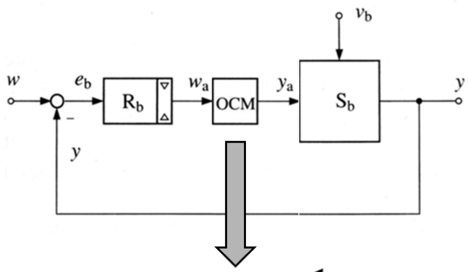
Block Diagram of the Cascade Control



Current control

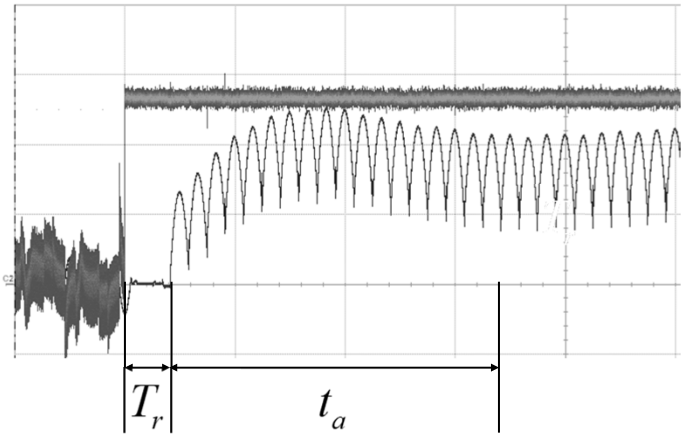


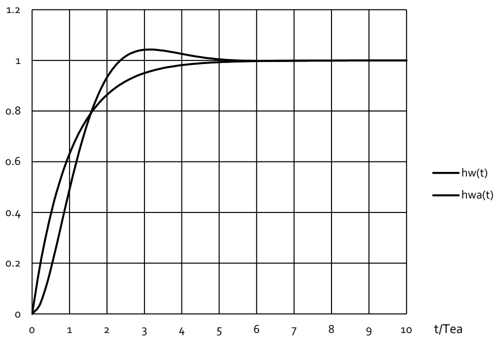
- The transfer function $G_{wa}(s)$ is the approximated form of the closed loop current control :



$$G_{wa}(s) = \frac{1}{1 + sT_{ea}}$$

Measure of T_{ea} and T_r

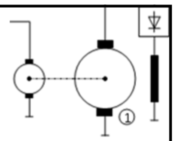




$$T_{ea} = \frac{t_a}{6}$$

$$\frac{t}{T_{ea}} = 6 \qquad T_{ea} = \frac{t}{6}$$

System to control



- The system to control is the mechanical part of a DC motor :

$$J\frac{d\Omega}{dt} = M_e - M_r$$

$$J\Omega_n \frac{dn}{dt} = M_n m_e - M_n m_r$$

$$T_m \frac{dn}{dt} = m_e - m_r \quad ; \quad T_m = \frac{J\Omega_n}{M_n}$$

System to control

- The system to control is the mechanical part of a DC motor :

$$T_m \frac{dn}{dt} = m_e - m_r \quad ; \quad T_m = \frac{J\Omega_n}{M_n}$$

$$m_e = \varphi i_a$$

$$T_m \frac{dn}{dt} = i_a - m_r \quad ; \quad \varphi = 1$$

System to control

- The system to control is the mechanical part of a DC motor :

$$T_m \frac{dn}{dt} = i_a - m_r$$

$$n = G_n(s) \cdot (i_a - m_r)$$

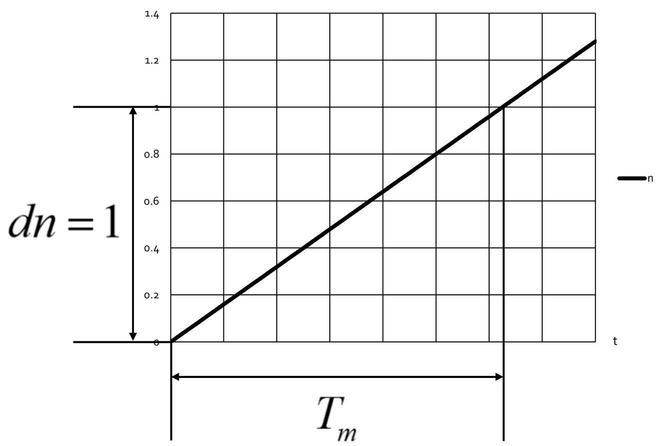
$$G_n(s) = \frac{1}{sT_m}$$

Measure of T_m

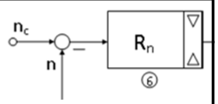
$$T_m \frac{dn}{dt} = i_a - m_r$$

$$\left.\begin{array}{l} i_a = 1 \\ m_r = 0 \end{array}\right\} T_m = \frac{dt}{dn}$$

$$dn = 1 \quad \Rightarrow \quad T_m = dt$$



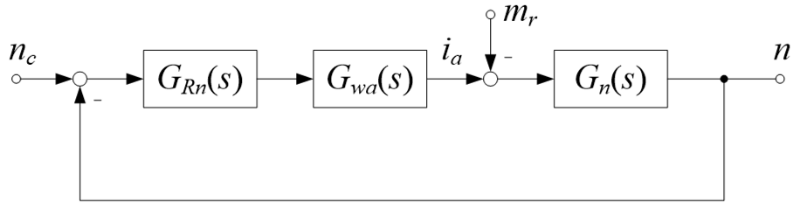
Speed controller



- The order of the system to control is 1 and the controller is a PI :

$$G_{Rn}(s) = \frac{1 + sT_n}{sT_i}$$

Block diagram of speed control

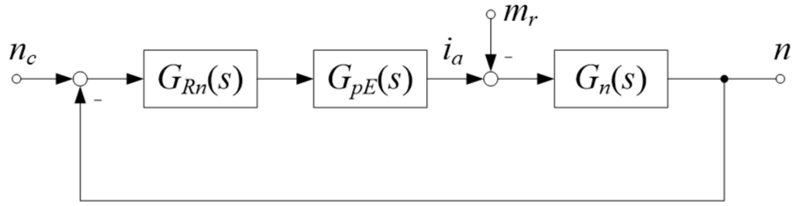


$$G_{Rn}(s) = \frac{1 + sT_n}{sT_i} \qquad G_{wa}(s) = \frac{1}{1 + sT_{ea}} \qquad G_n(s) = \frac{1}{sT_m}$$

Pseudo-continuous method

- A/D :  $G_{Mes}(s) = 1 \qquad T_{Mes} = 0$
- D/A :  $G_{me}(s) = \dfrac{1}{1 + s\dfrac{T_E}{2}}$
- Controller $G_{Rn}(s) = \dfrac{1 + sT_n}{sT_i}$

Resulting small time constant



$$G_{pE}(s) = \frac{1}{1 + sT_{pE}}$$

$$T_{pE} = \frac{T_E}{2} + T_{ea} + T_r$$

Dimensioning

- System is of integral behavior
- Symmetric Optimum (section 3.7.8)

$$T_n = 4T_{pE}$$

$$T_i = 8\frac{T_{pE}^2}{T_m}$$

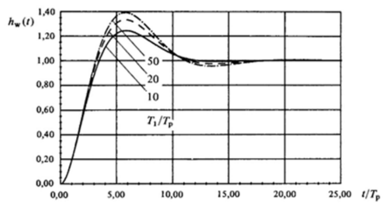
Digital implementation

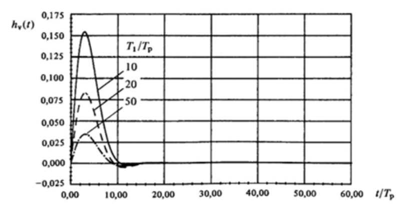
- Table 3.4

$$K_i = \frac{T_E}{T_i}$$

$$K_p = \frac{T_n - \frac{T_E}{2}}{T_i}$$

Symmetric Optimum





Corrector for the setpoint variable