§2

2.2. $D = \frac{1000}{100} = 10$

$D = \frac{n_N S}{\Delta n (1-S)}$ $\Delta n = 2.04\ r/min$

2.3 $D = \frac{n_{omax} - \Delta n_N}{n_{omin} - \Delta n_N} = 11$

$S = \frac{\Delta n_N}{n_{omin}} = 0.1$

2.4 $C_e = \frac{U_N - I_N R_a}{n_N} = 0.148\ V \cdot min/r$

$\Delta n_N = \frac{I_N (R_a + R_{ree})}{C_e} = 114.9\ r/min$

$D_1 = \frac{n_N S_1}{\Delta n_N (1-S_1)} = 3.11$

$D_2 = \frac{n_N S_2}{\Delta n_N (1-S_2)} = 5.33$

2.5 (1) $\Delta n_N = \frac{I_N R}{C_e} = 274.5\ r/min$

(2) $S_N = \frac{n_N}{n_N + \Delta n_N} = 0.78$

(3) $\Delta n_N = \frac{n_N S}{D(1-S)} = 2.63\ r/min$

§3

3. (1) $U_d = \frac{K_p K_s}{1+K_p K_s \gamma} \cdot U_n^* = 12V$

(2) $U_d = K_p K_s U_n^* = 264V$

$\frac{264}{12} = 22$

(3) $U_d = \frac{K_p K_s}{1+K_p K_s \gamma} \cdot U_n^*$

$U_n^* = 4.6V$

4. $D = \frac{1500}{150} = 10$

$\Delta n_d = \frac{n_N S}{D(1-S)} = 7.89 r/min$

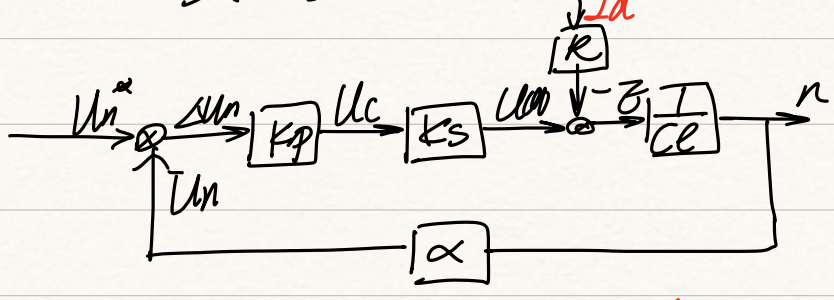
$K = \frac{\Delta n_{op}}{\Delta n_d} - 1 = 11.7$

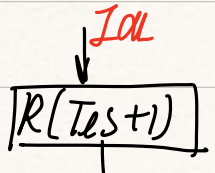
5. (1) $C_e = \frac{U_N - I_N R_a}{n_N} = 0.134 V \cdot min/r$

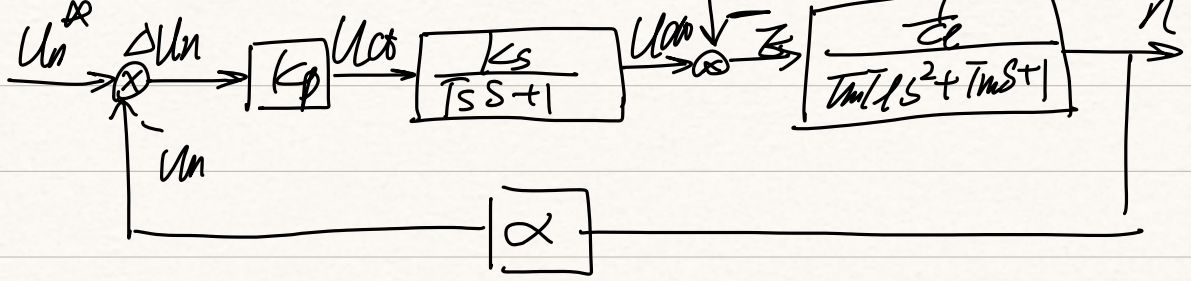
$\Delta n_{op} = \frac{I_N (R_a + R_{rec})}{C_e} = 149.3 r/min$

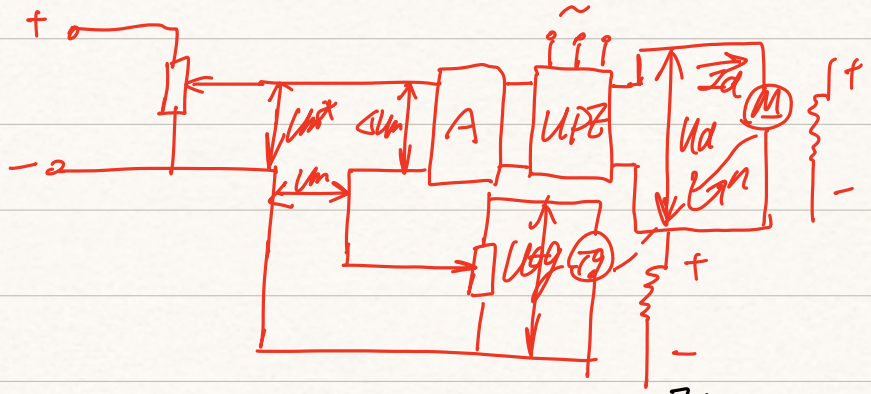
$\Delta n_d = \frac{n_N S}{D(1-S)} = 3.95 r/min$

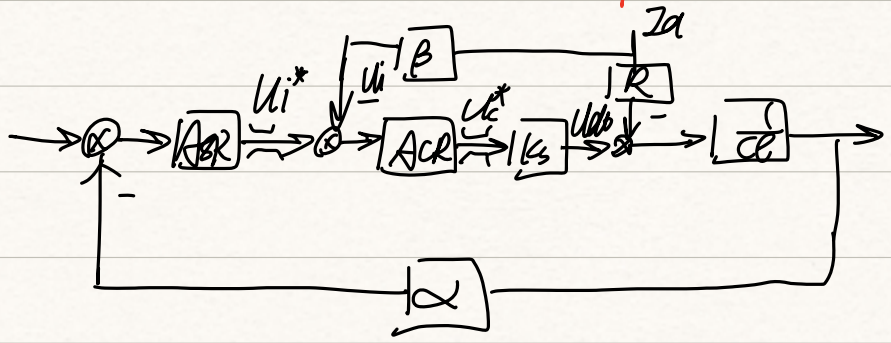
(2)











(3) $\alpha = \frac{U_{n}^{*}}{n_N} = 0.01\ V\cdot min/r$

(4) $K = \frac{\Delta n_{op}}{\Delta n_{cl}} - 1 = 36.8$

$K = \frac{K_p K_s \alpha}{C_e}$ $\quad K_p = 22.9$

3. (1) $\alpha = \frac{U_{nm}^*}{n_N} = 0.01\ V\cdot min/r$

$I_{dm} = \lambda I_N = 40A$

$\beta = \frac{U_{im}^*}{I_{dm}} = 0.375\ V/A$

$n = \frac{U_n^*}{\alpha} = 500\ r/min$

$U_n = 5V$

$U_i^* = U_i = \beta I_{dL} = 3.75V$

$U_c = \frac{U_{do}}{K_s} = \frac{C_e \cdot n + I_{dL} R}{K_s} = 4.175V$

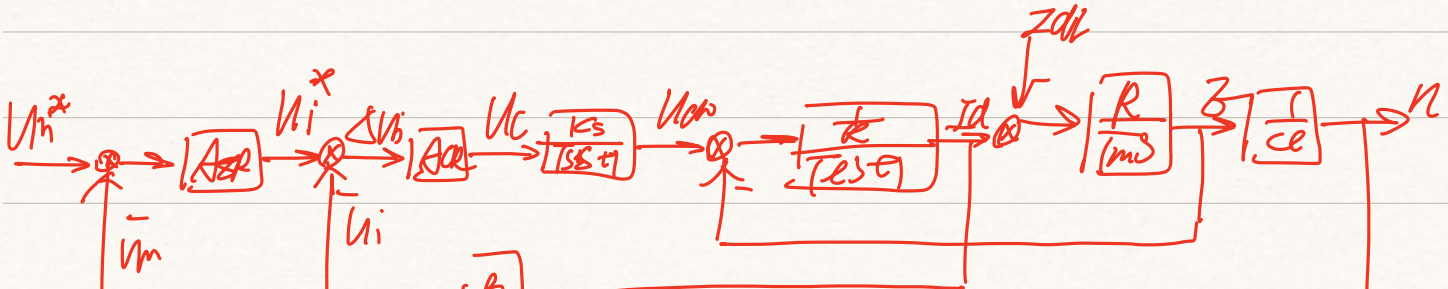
(2) $U_i^* = I_{dm}\beta = 15V$

$U_c = \frac{U_{do}}{K_s} = \frac{0 + I_{dm} R}{K_s} = 4\ V$

4. $\lambda = 2$

$U_s \uparrow \rightarrow K_s \uparrow \rightarrow U_{do} \uparrow \rightarrow 2\alpha \uparrow \rightarrow U_i \uparrow \rightarrow \Delta U_i \downarrow \rightarrow U_d$

$U_i^* = \beta I_{dL} \rightarrow U_{do} \downarrow \rightarrow I_d \downarrow$



5. $W_{obj}(s) = \frac{10}{0.01s+1}$

按工为典型I型系统 $W(s) = \frac{1}{\tau s}$

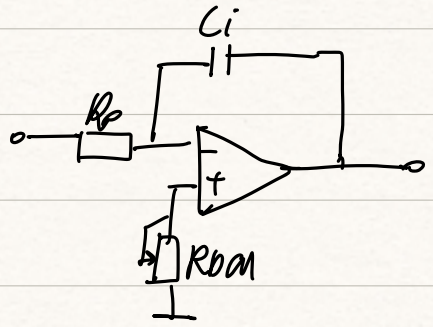
$W(s) = \frac{10K_i}{s(0.01s+1)}$ $K_T = 0.5$

$\frac{1}{10\tau_i} \times 0.01 = 0.5$

$\tau_i = 0.2$

$W(s) = \frac{50}{s(0.01s+1)}$

$W(s) = \frac{1}{0.2s}$



$\tau_i = C_i R_0$ $C_i = 5\mu F$

6. (1) $\beta = \frac{U_{im}^*}{1.5Z_N} = 0.01$ V/A

$\alpha = \frac{(U_n^*)_N}{n_N} = 0.01$ V·min/r

(2) 设计为典型I型系统

$W(s) = \frac{K_i(\tau_i s+1)}{\tau_i s}$

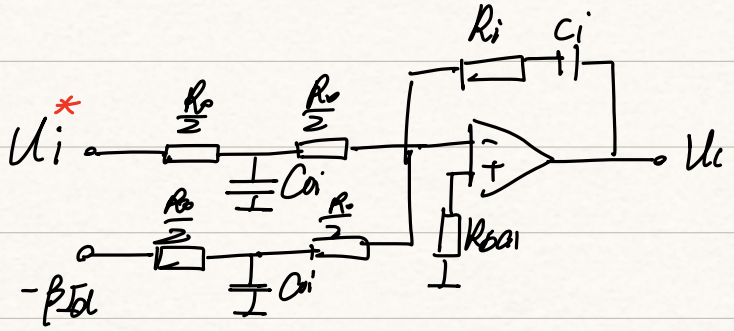
$T_s = \frac{1}{8\times 400} = 0.000125$ s

$T_{\Sigma i} = T_s + T_{oi} = 0.002625$ s

$K_I T_{\Sigma i} = 0.5$

$K_I = \frac{K_i K_s \beta}{\tau_i R}$ $\tau_i = T_\Sigma = 0.01$

$K_i = 0.32$



$K_i = \frac{R_i}{R_0}$ $R_i = 12.8k\Omega$

$\tau_i = R_i C_i$ $C_i = 0.78\mu F$

$T_{0i} = \frac{R_0 C_{oi}}{4}$ $C_{oi} = 0.25\mu F$

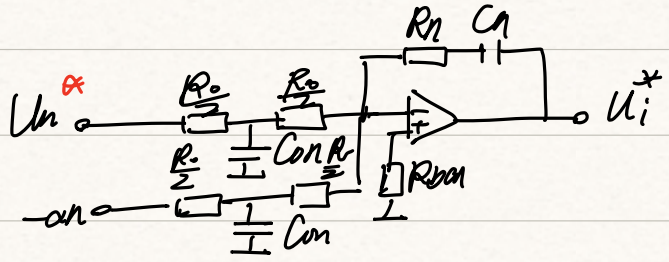
3) 设计为典型 I 型系统 $W_{ASR} = \frac{K_n(\tau_n s+1)}{\tau_n s}$

$T_{\Sigma n} = 2T_{\Sigma i} + T_{on} = 0.02025s$

$\tau_n = h T_{\Sigma n} = 0.10125s$

$K_N = \frac{K_n \alpha R}{\tau_n \beta C_e T_m} = \frac{h+1}{2h^2 T_{\Sigma n}^2}$

$K_n = 11.8$



$K_n = \frac{R_n}{R_0}$ $R_n = 472k\Omega$

$\tau_n = R_n C_n$ $C_n = 0.21\mu F$

$T_{on} = \frac{R_0 C_{on}}{4}$ $C_{on} = 1.5\mu F$

$\Delta n = \left(\frac{\Delta C_{max}}{C_N}\%\right) \times 2(\lambda - \delta) \cdot \frac{C_{N0}}{N^*} \cdot \frac{T_{\Sigma n}}{T_m}$

$= 81.2 \times 2 \times (1.5-0) \times \frac{157.1}{1000} \times \frac{0.02025}{0.12} = 6.46\% < 15\%$

$$\Delta n_N = \frac{I_N R}{C_e} = 61.71\ r/min$$

(4) $$\sigma_n = \left(\frac{\Delta C_{max}}{C_b}\%\right) 2(1-\beta) \cdot \frac{\Delta n_N}{n^*} \cdot \frac{T_{sn}}{T_m}$$

$$= 81.2 \times 2 \times (1.5-0.4) \times \frac{1571}{1000} \times \frac{0.02075}{0.12} = 47.4\% > 15\%$$

6. (1) $$\beta = \frac{U_{im}^*}{I_{dm}} = \frac{8}{1.5 \times 308} = 0.0173\ V/A$$

$$\alpha = \frac{(U_n^*)_N}{n_N} = \frac{10}{1000} = 0.01\ V \cdot min/r$$

(2) 设计成典型Ⅰ型系统

$$W_{ACR}(s) = \frac{K_i(\tau_i s+1)}{\tau_i s}$$

$$\tau_i = T_l = 0.01s$$

$$T_s = \frac{1}{f} = 0.00025s$$

$$T_{\Sigma i} = T_s + T_{oi} = 0.00275s$$

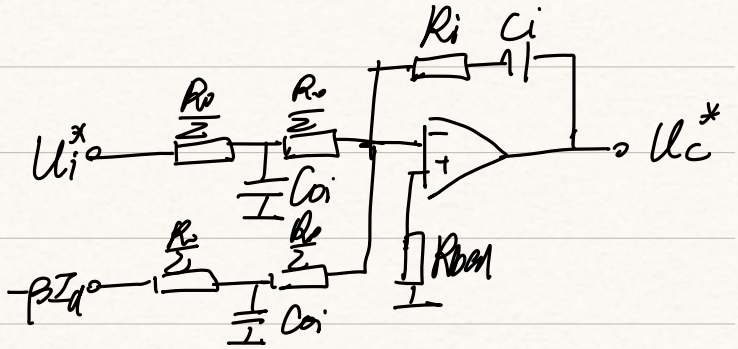
$$K_I T_{\Sigma i} = 0.5 \qquad K_I = \frac{K_i K_s \beta}{\tau_i R}$$

$$K_i = 0.31$$

$$K_i = \frac{R_i}{R_0} \qquad R_i = 12.4K\Omega$$

$$\tau_i = R_i C_i \qquad C_i = 0.81\mu F$$

$$T_{oi} = \frac{R_0 C_{oi}}{4} \qquad C_{oi} = 0.25\mu F$$



(3) 设计为典型I型系统 $W_{ASR}(s)=\frac{K_n(\tau_n s+1)}{\tau_n s}$

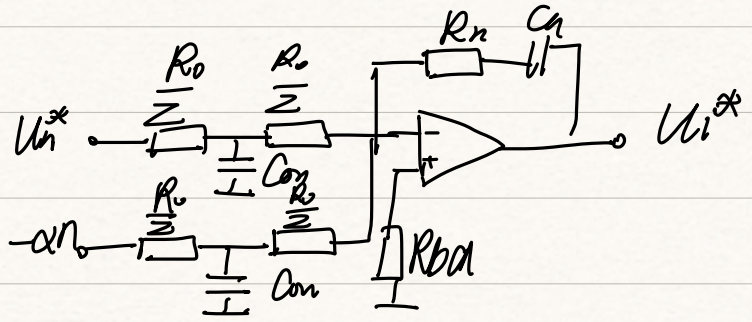
$T_{\Sigma n}=2T_{\Sigma i}+T_{on}=0.02025\,s$

$h=5$

$\tau_n=hT_{\Sigma n}=0.10125\,s$

$K_N=\frac{1+h}{2h^2T_{\Sigma n}}=\frac{K_n\alpha R}{\tau_n\beta C_e T_m}$

$K_n=12.1$



$K_n=\frac{R_n}{R_0}$ $R_n=61.9k\Omega$

$\tau_n=R_nC_n$ $C_n=0.21\mu F$

$T_{on}=\frac{R_0C_{on}}{4}$ $C_{on}=1.5\mu F$

$\Delta n_N=\frac{I_N R}{C_e}=157.1\,r/min$

$\sigma_n=\left(\frac{\Delta C_{max}}{C_b}\%\right)\times 2(\lambda-z)\cdot\frac{\Delta n_N}{n^*}\cdot\frac{T_{\Sigma n}}{T_m}$

$=81.2\times 2\times(1.5-0)\times\frac{157.1}{1000}\times\frac{0.02025}{0.12}=6.46\%<15\%$ ✓

(4) $\sigma_n=\left(\frac{\Delta C_{max}}{C_b}\%\right)\times 2(\lambda-z)\times\frac{\Delta n_N}{n^*}\cdot\frac{T_{\Sigma n}}{T_m}$

$=81.2\times 2\times(1.5-0.4)\times\frac{157.1}{1000}\times\frac{0.02025}{0.12}=47.4\%>15\%$ ×

$D=10=\frac{n_{max}}{n_{min}}$ $n_{min}=100$