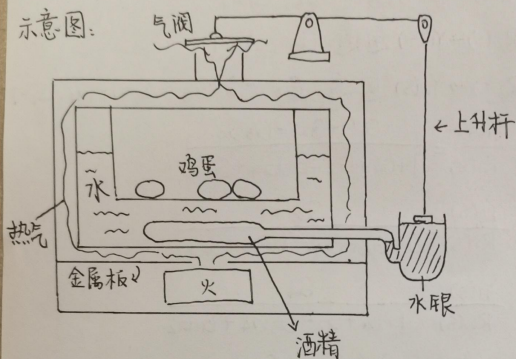班级：电14　　姓名：柳意轩　　编号：2021011536　　第　　页
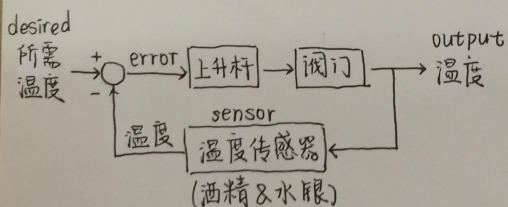
第一周：

1. 比飞球式调速器更早的自动控制系统：

荷兰人 (1572~1633) 发明的 培育箱温度调节器。

示意图：

原理与功能：

　　水将热量均匀地传递给内部鸡蛋层。温度传感器由酒精、水银等组成。当温度太高，水银上升，带动气阀下降，停止进气；当温度下降，水银下降，带动气阀上升，增加进气，促进温度升高。如此达到平衡 得到适宜培育的温度。

第二周：

1. (1) $s^3 Y(s) + 3s^2 Y(s) + 4s Y(s) + Y(s) = 2s U(s) + U(s)$

$$G(s) = \frac{Y(s)}{U(s)} = \frac{2s+1}{s^3 + 3s^2 + 4s + 1}$$
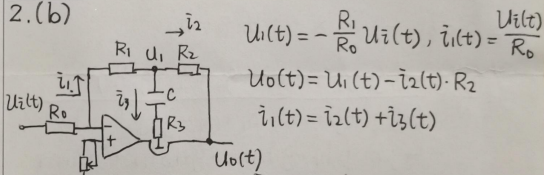
(2) $s^4 Y(s) + 6s^3 Y(s) + 10s Y(s) + 3 Y(s) = 7 U(s)$

$$G(s) = \frac{Y(s)}{U(s)} = \frac{7}{s^4 + 6s^2 + 10s + 3}$$

(3) $s^3 Y(s) + 2s^2 Y(s) + 8s Y(s) + Y(s) + \frac{5}{s} Y(s)$
$= 3s U(s) + U(s)$

$$\therefore G(s) = \frac{Y(s)}{U(s)} = \frac{3s+1}{s^3 + 2s^2 + 8s + 1 + \frac{5}{s}} = \frac{3s^2 + s}{s^4 + 2s^3 + 8s^2 + s + 5}$$

2. (b)

$U_1(t) = -\frac{R_1}{R_0} U_i(t)$，$i_1(t) = \frac{U_i(t)}{R_0}$

$U_0(t) = U_1(t) - i_2(t) \cdot R_2$

$i_1(t) = i_2(t) + i_3(t)$

$\Rightarrow I_3(s) = \frac{U_1(s)}{\frac{1}{Cs} + R_3} = \frac{-\frac{R_1}{R_0} U_i(s)}{\frac{1}{Cs} + R_3} = \frac{-CR_1 s \, U_i(s)}{R_0(1 + CR_3 s)}$

$I_2(s) = I_1(s) - I_3(s) = \left(\frac{1}{R_0} + \frac{CR_1 s}{R_0(1 + CR_3 s)} \right) U_i(s)$

$U_0(s) = U_1(s) - R_2 I_2(s)$

$\therefore G(s) = \frac{U_0(s)}{U_i(s)} = -\frac{R_1}{R_0} - \left(\frac{1}{R_0} + \frac{CR_1 s}{R_0(1 + CR_3 s)} \right) R_2$

$= - \frac{(R_1 + R_2)(1 + CR_3 s) + CR_1 R_2 s}{R_0(1 + CR_3 s)}$

3. (c)

$f = \mu_1 (x_i'(t) - x_1'(t)) + k_1(x_i(t) - x_1(t))$

$= \mu_2(x_1'(t) - x_0'(t)) = k_2 x_0(t)$

$\Rightarrow x_1'(t) = \frac{k_2}{\mu_2} x_0(t) + x_0'(t)$

$x_1(t) = \frac{\mu_1}{k_1} x_i'(t) + x_i(t) - \frac{(\mu_1 + \mu_2) k_2}{k_1 \mu_2} x_0(t)$
$\quad - \frac{\mu_1}{k_1} x_0'(t)$

代回等式 ⇒

$$\frac{u_1 u_2}{k_1 k_2}\chi_0''(t) + (\frac{u_1}{k_1}+\frac{u_2}{k_1}+\frac{u_2}{k_2})\chi_0'(t) + \chi_0(t)$$
$$= \frac{u_1 u_2}{k_1 k_2}\chi_i''(t) + \frac{u_2}{k_2}\chi_i'(t)$$

$$G(s) = \frac{X_0(s)}{X_i(s)} = \frac{\frac{u_1 u_2}{k_1 k_2}S^2 + \frac{u_2}{k_2}S}{\frac{u_1 u_2}{k_1 k_2}S^2 + (\frac{u_1+u_2}{k_1}+\frac{u_2}{k_2})S + 1}$$

5.(b)

单个回路：$-g_1 h_3$, $-g_2 h_2$, $-g_3 h_1$, $-h_4$,
   $-g_4 g_5 h_1 h_2 h_3$

通道：$g_1 g_2 g_3$, 与 $-h_4$ 不接触，$\Delta_1 = 1+h_4$
   $g_4 g_5$, 与 $-g_2 h_2$ 不接触，$\Delta_2 = 1+g_2 h_2$

两两不接：$-g_1 h_3 \& -g_3 h_1$, $-g_1 h_3 \& -h_4$, $-g_2 h_2 \& -h_4$,
   $-g_3 h_1 \& -h_4$

三三不接：$-g_1 h_3 \& -g_3 h_1 \& -h_4$

$$\therefore G = \frac{Y}{R} = \frac{g_1 g_2 g_3(1+h_4) + g_4 g_5(1+g_2 h_2)}{1+g_1 h_3+g_2 h_2+g_3 h_1+h_4+g_4 g_5 h_1 h_2 h_3} $$
$$+g_1 h_3 g_3 h_1+g_1 h_3 h_4+g_2 h_2 h_4+g_3 h_1 h_4 $$
$$+g_1 h_3 g_3 h_1 h_4$$

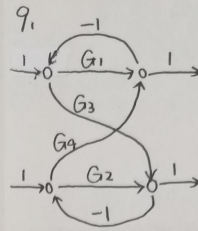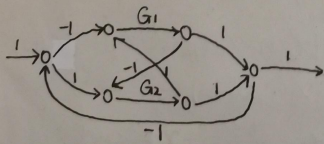### 6.(c)

回路：G_1, $-G_2$, $-G_1 G_2$, $-G_1 G_2$, $-G_1 G_2$ 两两接触

通道：G_2, $-G_1$, $G_1 G_2$, $G_1 G_2$ 都与各回路接触
   $\Delta_1 = \Delta_2 = \Delta_3 = \Delta_4 = 1$

$$\therefore G = \frac{Y}{R} = \frac{G_2 - G_1 + 2G_1 G_2}{1 - G_1 + G_2 + \textcolor{red}{3}\ 2G_1 G_2}$$

9.

回路：$-G_1$, $-G_2$, $G_3 G_4$

两两不接：$-G_1 \& -G_2$

$R_1(s) \to Y_1(s)$ 通道：G_1, $-G_3 G_4$
   $\Delta_1 = 1+G_2$, $\Delta_2 = 1$

$R_1(s) \to Y_2(s)$ 通道：G_3, $\Delta_1 = 1$

$R_2(s) \to Y_1(s)$ 通道：G_4, $\Delta_1 = 1$

$R_2(s) \to Y_2(s)$ 通道：G_2, $-G_3 G_4$, $\Delta_1 = 1+G_1$, $\Delta_2 = 1$

$$\therefore \frac{Y_1(s)}{R_1(s)} = \frac{G_1(1+G_2) - G_3 G_4}{1+G_1+G_2-G_3 G_4+G_1 G_2}$$

$$\frac{Y_2(s)}{R_1(s)} = \frac{G_3}{1+G_1+G_2-G_3 G_4+G_1 G_2}$$

$$\frac{Y_1(s)}{R_2(s)} = \frac{G_4}{1+G_1+G_2-G_3 G_4+G_1 G_2}$$

$$\frac{Y_2(s)}{R_2(s)} = \frac{G_2(1+G_1) - G_3 G_4}{1+G_1+G_2-G_3 G_4+G_1 G_2}$$