QP code: 9986

Q.1.

f) Relation between level & Current :

$H = k \cdot I + H_0$

$5m = k \cdot (4mA) + H_0 \rightarrow (1)$

$10m = k(20mA) + H_0 \rightarrow (2)$

$\therefore 5 = 4k + H_0$

$10 = 20k + H_0$

$5 = 16k$

$k = 5/16 = 0.3125\ m/mA$

from eq. (1) . Substituting k.

$5 = 4(0.3125) + H_0$

$H_0 = 3.75$

Now, Relay closes at 12mA i.e High level (H_H)

$H_H = k \cdot I + H_0$

$= (0.3125) \times 12 + 3.75$

$H_H = \underline{\underline{7.5\ m}}$

Relay opens at 10mA i.e Low level (H_L)

$H_L = (0.3125) \times 10 + 3.75$

$H_L = \underline{\underline{6.875}}$

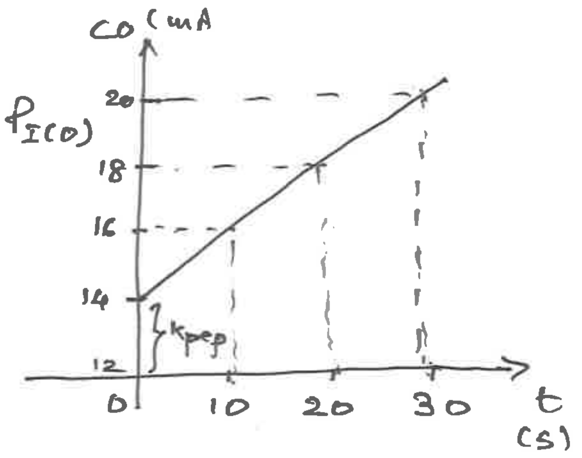
Neutral Zone $= H_H - H_L$

$= 7.5 - 6.875 = \underline{\underline{0.625\ m}}.$

Q.2.b

Controller Output (CO) is given by

$$CO = K_p e_p + K_p K_I \int_0^t e_p\,dt + P_{I(0)}$$



$P_{I(0)} = 12\,mA$ (Given)

$e_p = 14 - 12 = 2\,mA$

$\therefore e_p = 2\,mA$

Proportional component from graph = 2

$\therefore K_p e_p = 2$

$\therefore K_p = 2/2 = 1$

Integral component

$$K_p \cdot K_I\, e_p (t)\Big|_0^t = K_p K_I e_p t + P_{I(0)}$$

$\therefore$ Say for 18 mA. $t = 20\,s$

$18 = 1 \times 2 + 1 \times K_I \times 2 \times 20 + 12$

$K_I = 0.1$

$T_I = 1/K_I = $ 10 Secs.

Proportional gain = 1

Integral time = 10 Secs.

Q.3.b.

$$Y_1 = \frac{1}{S+1} m_1 + \frac{1}{0.1S+1} m_2 \longrightarrow (1)$$

$$Y_2 = \frac{-0.2}{0.5S+1} m_1 + \frac{0.8}{S+1} m_2 \longrightarrow (2)$$

i) Make unit step change in ($m_1 = 1/S$) keeping m_2 constant ($m_2 = 0$)

from eq. (1)

$$\therefore Y_1 = \frac{1}{S+1} \cdot \frac{1}{S}$$

By final value theorem steady state value of Y_1 is

$$\lim_{S \to 0} [S \cdot Y_1(s)] = \lim_{S \to 0} S \cdot \frac{1}{S+1} \cdot \frac{1}{S} = 1$$

$$\therefore \left(\frac{\Delta Y_1}{\Delta m_1} \right)_{m_2} = 1/1 = 1$$

ii) Keep Y_2 = constant ($Y_2 = 0$). Make unit step change in $m_1 = 1/S$.

$\therefore$ from eq. (2)

$$m_2 = \frac{0.2}{0.8} \cdot \frac{S+1}{0.5S+1} \cdot m_1$$

putting this value of m_2 in eq. (1)

$$Y_1 = \frac{1}{S+1} \cdot m_1 + \frac{1}{0.1S+1} \cdot \frac{0.2}{0.8} \cdot \frac{S+1}{0.5S+1} \cdot m_1$$

By final value Theorem steady state value of Y_1 ($\because m_1 = 1/S$)

$$= \lim_{S \to 0} [S \cdot Y_1(s)] = \lim_{S \to 0} S \left[\frac{1}{S+1} + \frac{1}{0.1S+1} \cdot \frac{0.2}{0.8} \cdot \frac{S+1}{0.5S+1} \right] \times \frac{1}{S}$$

$$= 1 + \frac{0.2}{0.8} = 1.25$$

$$\left[\frac{\Delta Y_1}{\Delta m_1} \right]_{Y_2} = \frac{1.25}{1} = 1.25$$

$$\lambda_{11} = \frac{\left(\frac{\Delta Y_1}{\Delta m_1} \right)_{m_2}}{\left(\frac{\Delta Y_1}{\Delta m_1} \right)_{Y_2}} = 0.8$$

$\therefore \lambda_{11} = \underline{\underline{0.8}}$ $\quad \lambda_{22} = \underline{\underline{0.8}}$

$\lambda_{12} = \underline{\underline{0.2}}$ $\quad \lambda_{21} = \underline{\underline{0.2}}$

$\because \lambda_{11} + \lambda_{12} = 1 \quad \lambda_{21} + \lambda_{22} = 1$

$\lambda_{21} + \lambda_{11} = 1 \quad \lambda_{22} + \lambda_{12} = 1$

Q5.b. Inputs / O/ps.

Start_Button = START

Stop_Button = STOP

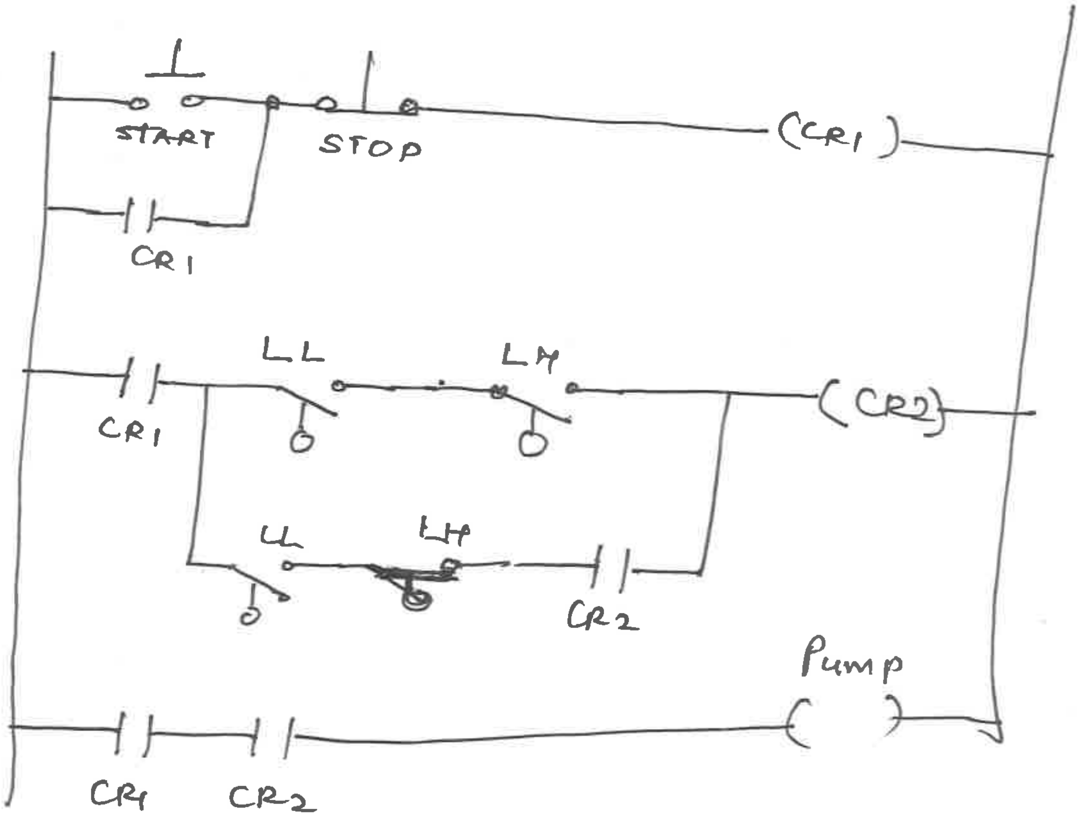
Control Relay (Software Relay) : CR1

Low level = LL

High level = LH

Control Relay (Software Relay) = CR2

O/p = Pump



OR