مدرس مقرر+ إمتحان؟
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نموذج الإجابة الخاص بامتحان التحكم الآلي.

Apply K.V.L.

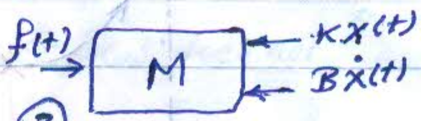
$$v(t) = R\,i(t) + L\frac{di(t)}{dt} + e_b(t)$$

$$I(S) = \frac{V(S) - E_b(S)}{R + LS} \quad (1)$$

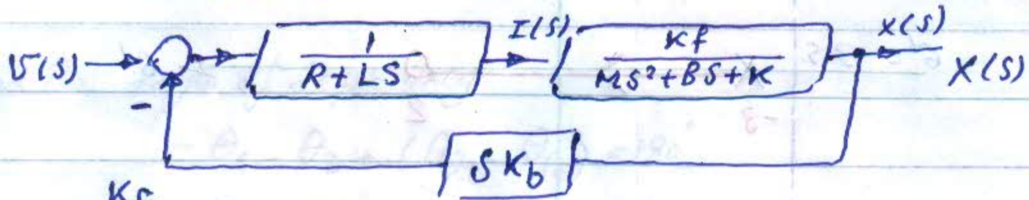
$$e_b \propto \dot{x}(t), \quad so, \quad e_b = K_b\dot{x}(t)$$

$$E_b(S) = K_b\,S\,X(S) \quad (2)$$

$$m\ddot{x}(t) = f(t) - Kx(t) + B\dot{x}(t)$$



$$X(S) = \left(\frac{K_f}{MS^2 + BS + K}\right) I(S) \quad (3)$$



$$\frac{X(S)}{V(S)} = \frac{K_f}{LMS^3 + (LB + RM)S^2 + (KL + RB + K_bK_f)S + RK}$$

Q1.1

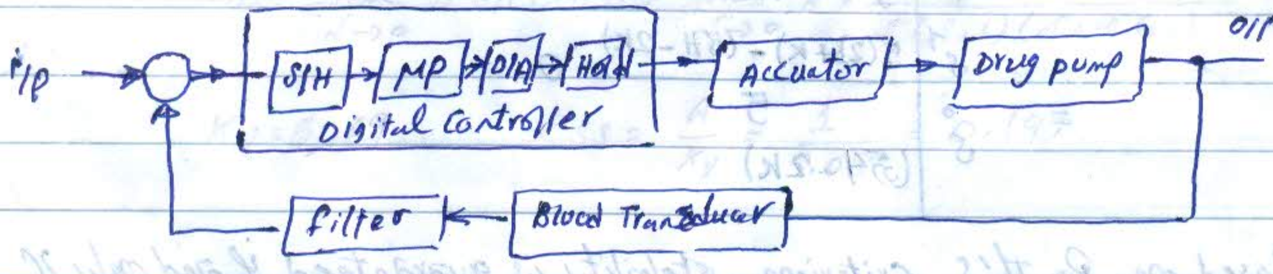
Set $b_1 = 1$ $\quad V_F = 5(2^{-1}) = 2.5, \quad V_x > 2.5$ leave $b_1 = 1$

Set $b_2 = 1$ $\quad V_F = 2.5 + 5(2^{-2}) = 3.75^v \quad V_x < 3.75$ reset $b_2 = 0$

Set $b_3 = 1$ $\quad V_F = 2.5 + 5(2^{-3}) = 3.125^v \quad V_x > 3.125$ leave $b_3 = 1$

Set $b_4 = 1$ $\quad V_F = 3.125 + 5(2^{-4}) = 3.4375 \quad V_x < 3.4375$ reset $b_4 = 0$

By this procedure, we find the output is a binary word of 1010.

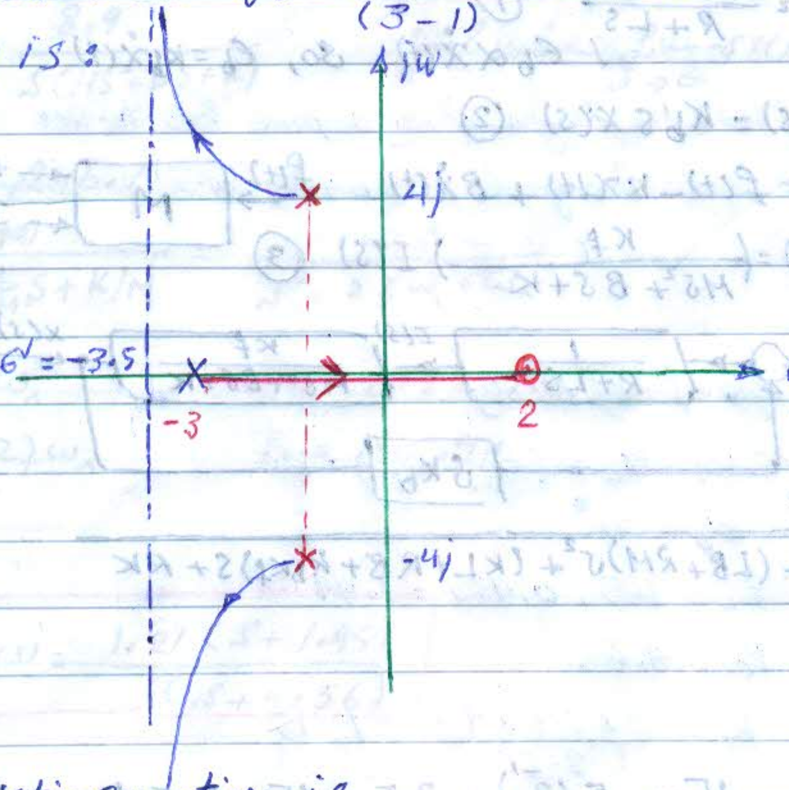


(Q 1.3)

(a) The pole and zeros of P(s) are $P_1 = -3$, $P_{2,3} = -1 \pm j4$ & $z_1 = 2$

The relative degree is $n - 3 = 2$. Therefore there exist two asymptotes at $\pm 90°$, located at $\sigma = \frac{(-3-1-1)-2}{(3-1)} = -3.5$

The root locus is:



b) The characteristic equation is

$$(s+3)(s^2+2s+17) + K(s-2) = 0$$

$$s^3 + 5s^2 + (23+K)s + (51-2K) = 0$$

s^3	1	$(23+K)$
s^2	5	$(51-2K)$
s^1	$\frac{5(23+K)-(51-2K)}{5}$	0
s^0	$(51-2K)$	

Based on Routh's criterion, stability is guaranteed if and only if

$51 - 2K > 0$ i.e $K < 25.5$

Therefore: $0 < K < 25.5$

$Q_{2,1}$

$$M_p = e^{-\pi\zeta/\sqrt{1-\zeta^2}} \qquad \ln(0.15) = \frac{-\pi\zeta}{\sqrt{1-\zeta^2}} \qquad \zeta = 0.5$$

$$T_d = \frac{1-0.7\zeta}{\omega_n} = 0.435 \qquad \omega_n = 3\ \text{rad/sec}$$

$$s_D = -\zeta\omega_n \pm j\omega_n\sqrt{1-\zeta^2}$$
$$= -1.5 \pm j2.598$$

its obvious That The design using a pure P-Controller does not lead to The goal as The root locus does not traverse The domaint point

Find The angle of deficiency

$$-\theta_1 - \theta_2 + (\theta_{Z_c} - \theta_{P_c}) = 180^\circ$$

$$\theta_D = 41^\circ$$

$$Z_c = 1.5 + 0.435 = 1.94$$

$$P_c = 4.65$$

$$K = \frac{3 \times 2.7 \times 4.2}{2.8} = 12.15$$

$$G_c = \frac{1.215(s+1.94)}{(s+4.65)}$$

$$G_c G_p = \frac{12.5(s+1.94)}{s(s+1)(s+4.65)}$$

$$K_v = \lim_{s\to 0} s\,G(s)H(s) = \lim_{s\to 0} s \times \frac{12.5(s+1.94)}{s(s+1)(s+4.65)}$$

$$K_v = 5.069 \qquad e_{ss} = \frac{A}{K_v} = \frac{1}{5.069} = 0.197$$

$Q_{2.1}$

$$G_p = \frac{K_p \pi(s+Z_i)}{s^j \pi(s+P_i)}, \quad G_c = \frac{k_c(s+Z_c)}{(s+P_c)} \qquad G_p G_c = \frac{K_p K_c(s+Z_i)(s+Z_c)}{s^j(s+P_c)\pi(s+P_i)}$$

let $j=1$

$$K_v = \lim_{s\to 0} s\,G_p G_c = K\,\frac{Z_c}{P_c}\cdot\frac{\pi Z_i}{\pi P_i}$$; The Compensator is lead $P_c > Z_c$

$\therefore \frac{Z_c}{P_c} < 1$ $\quad K_v$ will decrease

$e_{ss} = \frac{A}{K_v}$ Steady State error will increase.