THE HONG KONG POLYTECHNIC UNIVERSITY

HONG KONG COMMUNITY COLLEGE

Subject Title : Flight Control Systems **Subject Code** : CCN2297

Session : Semester One, 2017/18

Numerical Answers

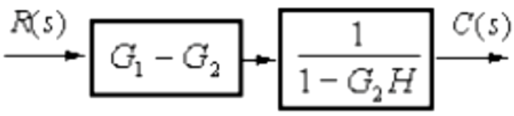
Question A2

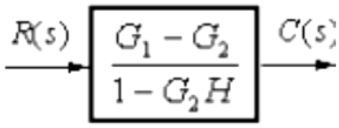
The closed-loop system transfer function has the general form G(s)/(1+H(s)G(s)).

Characteristic equation is:

$$(s^2+6s+100)+(2s+1)=0$$

Question A3





Question A4

(a) $K/(s^2 + as + K)$

(b)

$$\omega_n = \sqrt{K} \qquad \zeta = \frac{a}{2\omega_n} = \frac{a}{2\sqrt{K}}$$

$$\sigma_p = e^{-\frac{\zeta\pi}{\sqrt{1-\zeta^2}}} \times 100\% = 10\%$$

$$-\frac{\zeta\pi}{\sqrt{1-\zeta^2}} = \ln 0.1 = -2.3 \implies \zeta = 0.59$$

$$t_s = \frac{3}{\zeta\omega_n} = 2 \implies \omega_n = 2.54 \implies K = 6.46$$

$$a = 2\zeta\omega_n = 3$$

Question B1

(b) $$\frac{\omega_n{}^2(s+k)}{s^3+2\zeta\omega_n s^2+\omega_n{}^2 s+K\omega_n{}^2}$$

(c) Characteristic equation is:

$$s^3+2\zeta\omega_n s^2+\omega_n{}^2 s+K\omega_n{}^2=0$$

Routh table:

s^3	1	7500
s^2	34. 6	7500K
s^1	$\frac{346\times 7500-7500K}{34.6}$	
s^0	7500K	

$$\frac{34.6\times 7500-7500K}{34.6}>0$$

$$0<K<34.6$$

Question B2

(b) E(s) = R(s) – H(s) = $-\frac{10}{(0.1s+1)(0.2s+1)(0.5s+1)+10K_1}$

e(s) = $\lim_{s\to 0} s\cdot E_n(s)=-\frac{10}{1+10K_1}$

(c) The characteristic equation of the system is:

$$(0.1s + 1)(0.2s + 1)(0.5s + 1) + 10K_1 = 0$$

$$S^3 + 17s^2 + 80s + 100 + 1000K_1 = 0$$

By checking with Routh table, the system is unstable!

(d) To make the system stable:

$$K_1<\frac{17\times 80-100}{1000}=1.26$$

This will make e(s) > 0.735 but contradiction to e(s) = -0.1

Therefore, K_1 has no value to make the system stable at e(s) = -0.1