solution to exam 3, Feb.1995

1. $K_c = \frac{1}{9}$

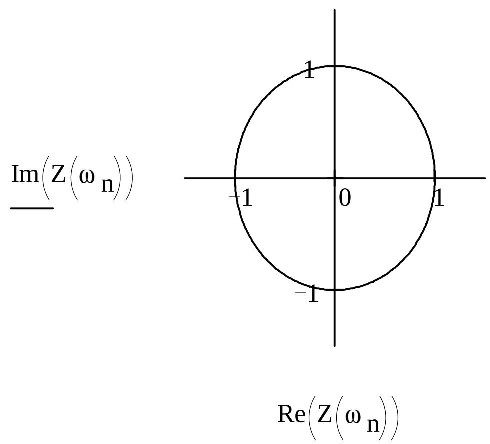
2. $z(s) = \exp(Ts)$

$z(i\cdot\omega) = \exp(i\cdot\omega\cdot T) = \cos(\omega\cdot T) + i\cdot\sin(\omega\cdot T)$

$|z(i\cdot\omega\cdot T)| = 1$

$\arg(z(i\cdot\omega\cdot T)) = \omega\cdot T$

Let $\omega_n = \omega\cdot T$ $\quad \omega_n := 0, 0.01 .. 2\cdot\pi \quad Z(\omega_n) := \exp(i\cdot\omega_n)$



$20\cdot\log(0.03) = -30.458$

3. a) For $GM := 10 \quad LM(K_c\cdot G_m\cdot G_p\cdot G_v) = 20\cdot\log\left(\frac{1}{10}\right)$

$LM(K_c) = -20 - 15 = -35\cdot dIK_c = 10^{-\frac{35}{20}} = 0.018$

b) For $K_c = 0.03 \qquad LM(K_c) = 20\cdot\log(0.03) = -30.5$

the corresponding phase shift after Kc is implented will be -90^o.

$PM = 180 - 90 = 90\cdot deg$

4. Characteristic polynomial: $s^3 + s^2 - 4 \cdot s - 4 + K_c \cdot (s - 1) = 0$

$$s^3 + s^2 + (K_c - 4) \cdot s - K_c - 4 = 0$$

Routh Hurwitz:

$$\begin{bmatrix} 1 & (K_c - 4) \\ 1 & -(K_c + 4) \\ 2 \cdot K_c & 0 \\ -(K_c + 4) & 0 \end{bmatrix}$$

for stability, we need $K_c>0$ and $K_c<-4$ which is impossible. Thus the system can not be stabilized by proportional control.

5. $GM = \frac{1}{0.25} = 4$ $PM = 60 \cdot deg$

6. $PhaseShift := (40 - 55) \cdot \frac{2 \cdot \pi}{(60 - 40)}$

$PhaseShift = -270 \cdot deg$

$MagnitudeRatio = 1$

7. Case 1: G4
Case 2: G1
Case 3: G8
Case 4: G7