# Solution to exam 3, April 24, 2003

1. $P := 10$ $\phi := -200$ $LM := 7$ $A := 10$

$\omega := \frac{2\cdot\pi}{P}$ $\omega = 0.628$

$t_{shift} := \left(\phi\cdot\frac{\pi}{180}\right)\cdot\frac{1}{\omega}$ $t_{shift} = -5.556$

$MR := 10^{\frac{LM}{20}}$ $MR = 2.239$

$B := A\cdot MR$ $B = 22.387$

2. a ) $K_c\cdot 0.6 = \frac{1}{3}$ $K_c := \frac{1}{3\cdot 0.6}$ $K_c = 0.556$

b ) $K_c\cdot\sqrt{2} = 1$ $K_c := \frac{1}{\sqrt{2}}$ $K_c = 0.707$

3. LM @ $\omega_{pc}$ = 6.5 dB $20\cdot\log(K_u) = -6.5$

$K_u := 10^{\frac{-6.5}{20}}$ $K_u = 0.473$

$P_u := \frac{2\cdot\pi}{1}$ $P_u = 6.283$

$K_c := \frac{K_u}{1.7}$ $K_c = 0.278$

$\tau_I := \frac{P_u}{2}$ $\tau_I = 3.142$

$\tau_D := \frac{P_u}{8}$ $\tau_D = 0.785$

4. Case 1: G8

Case 2: G3

Case 3: G2

Case 4: G4

5.

$$G(s) = \frac{\left(\frac{1}{s+1}\right)}{1 + \left(\frac{1}{s+1}\right)\cdot\left(\frac{2}{s+2}\right)} = \frac{(s+2)}{\left(s^2 + 3\cdot s + 4\right)}$$

$$G(i\cdot\omega) = \frac{(i\cdot\omega + 2)}{\left(-\omega^2 + 3\cdot i\cdot\omega + 4\right)}$$

$$MR(\omega) := \frac{\sqrt{2^2 + \omega^2}}{\sqrt{\left(4 - \omega^2\right)^2 + 9\cdot\omega^2}}$$

6. poles: -1 + i, -1 - i zeroes: none

only the pole -1-i is inside the path

thus, $Z := 0$ $P := 1$

$N := Z - P$ $N = -1$

or one counterclockwise encirclement of the origin.