Eskişehir Osmangazi University - Electrical Engineering Department Fundamentals of Control Systems Final Examination - Spring 2006



Figure 1: Block diagram referenced by Problem 1

1. [40] Consider block diagram of Figure 1 and let r(t) = 2u(t), where u(t) is the unit step function.

a) Obtain the transfer function $\frac{C(s)}{R(s)}$ in the second order form. Write the values of w_n and ξ .

b) Compute the steady state value of c(t).

c) Compute the rise time (i.e., the first time it reaches its steady state value.)

d) Compute the first peak time and c(t) at this peak.



Figure 2: Block diagram referenced by Problem 2

2. [30] Sketch the root loci for the configuration in Figure 2.

3. [30] Sketch the asymptotic Bode Plot for $T(s) = \frac{5}{(s+20)(s+50)}$. Good Luck,

A. Karamancıoğlu

Solutions

1.a
$$\frac{C(s)}{R(s)} = \frac{1}{s^2 + 0.5s + 1}, \quad w_n = 1, \quad \xi = 0.25$$

1.b $\lim_{t \to \infty} c(t) = \lim_{s \to 0} sC(s) = \lim_{s \to 0} s \frac{1}{s^2 + 0.5s + 1} \frac{2}{s} = 2$
1.c $t_r = \frac{\pi - \beta}{w_d} = \frac{\pi - \cos^{-1} \xi}{w_n \sqrt{1 - \xi^2}} = \frac{\pi - 1.3181}{0.9682} = 1.88$ secs.
1.d $t_p = \frac{\pi}{w_d} = \frac{\pi}{0.9682} = 3.2447$ secs. $c(t_p) = 2(1 + e^{\frac{-\xi\pi}{\sqrt{1 - \xi^2}}}) = 2.88$



Figure 3: The time response for Problem 1



Figure 4: The root locus



Figure 5: Bode-magnitude



Figure 6: Bode-phase