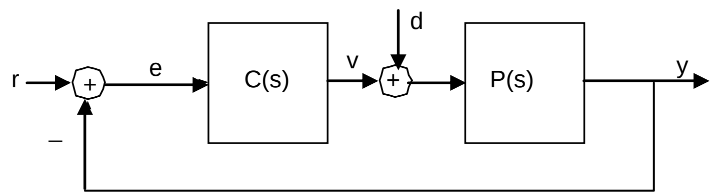
EEE 304 **Test 5** **Name: ___SOLUTIONS___**

Closed-book closed-notes, tables allowed, 30'

Problem 1:

For the feedback system shown below, compute the transfer functions from r to e (e/r) and from d to e (e/d).



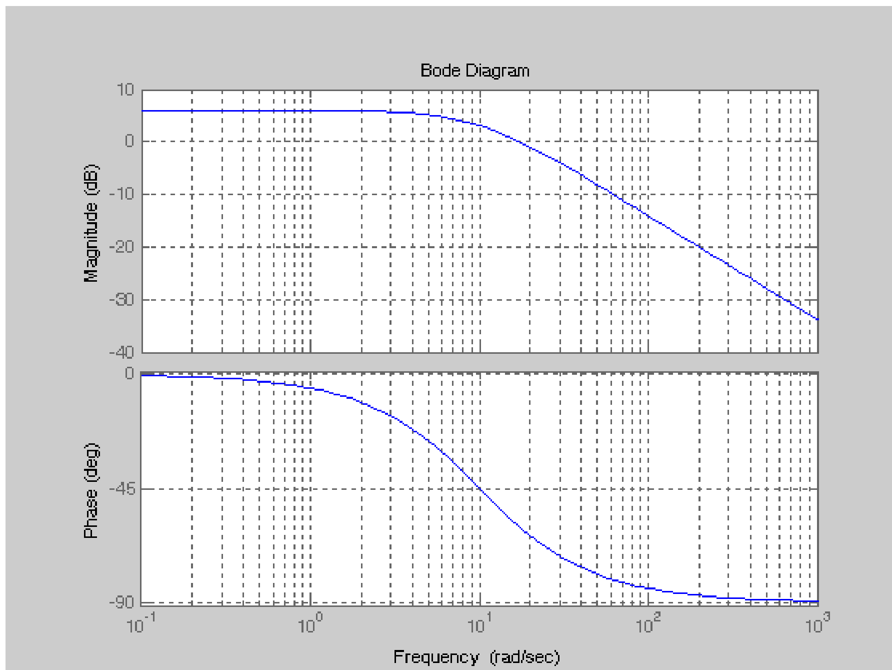
$$\frac{e(s)}{r(s)} = \frac{1}{1+P(s)C(s)}, \quad \frac{e(s)}{d(s)} = \frac{-P(s)}{1+P(s)C(s)}$$

Problem 2:

For the feedback system of Problem 1, suppose $P(s) = 2/(0.1s+1)$ and $C(s) = K(Ts+1)/s$. Determine K,T so that the crossover frequency is 10 and the Phase Margin is at least 60^o.

(You may use the given Bode plot to compute the necessary quantities graphically.)

At w = 10 rad/s, arg(P) is -45deg. Adding the controller integrator will produce an angle -135deg. We, therefore, need +15deg from the controller zero to obtain the desired -120deg (PM = 60). Thus,



$$\arg(Tjw_{GC}+1) = 15° \Rightarrow 10T = \tan\left(\frac{15\pi}{180}\right) \Rightarrow T = 0.027$$

Next, we compute K so that

$$|C(jw_{GC})P(jw_{GC})| = 1 \Rightarrow K = \frac{w_{GC}|0.1jw_{GC}+1|}{|Tjw_{GC}+1|2} = 6.8$$

The final controller is

$$C(s) = \frac{6.8(0.027s+1)}{s}$$