Department of Chemical Engineering

CHL 261 Instrumentation & Process Control: Major Exam (closed book & notes)

Duration: 2 hr | Max Marks: 40 | 25^{th} Nov 2013

(1) Plot the root locus diagram for the control system shown in Fig.1 using rule based method. Determine the center of gravity, angle of asymptotes, breakaway point(s). Determine whether the root locus crosses the imaginary axis or not, and if yes, then find the pair of imaginary roots, and the value of K_c for the system to be marginally stable. [15 M]

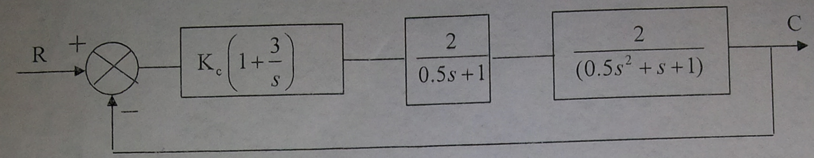

Fig. 1. Block diagram of a control system

(2) Plot asymptotic Bode diagram for a PD controller with derivative filter using $\tau_D = 10$, $\beta = 0.1$, by first tabulating the low, high, and corner frequency data for individual amplitudes and phase angles. Show both individual and overall plots on the same graph. [10 M]

$$G_c = K_c\left(\frac{\tau_D s+1}{\beta\tau_D s+1}\right)$$

(3) The data given in Table 1 represents experimental frequency response data for a process consisting of a first order and transportation lag. (a) Determine time constant, transportation lag, corner frequency, crossover frequency, gain margin, and phase margin. (b) Apply Bode stability criterion. (c) Now, consider a PID controller and determine Zeigler-Nichols controller settings. [15 M]

Table 1. Frequency Response data

	Frequency (cpm)	Gain	Phase angle (deg)
0.0628	0.01	1.0	0.0
0.1256	0.02	1.0	-2.0
0.2512	0.04	1.0	-6.0
	0.06	1.0	-7.0
	0.08	1.0	-8.5
	0.1	1.0	-11.0
	0.15	1.0	-17.0
	0.2	1.0	-23.0
	0.3	1.0	-36.0
	0.4	0.98	-48.0
	0.6	0.94	-73.0
	0.8	0.88	-96.0
	1.0	0.83	-122.0
3π rad.	1.5	0.71	-180.0
	2.0	0.61	-239.0