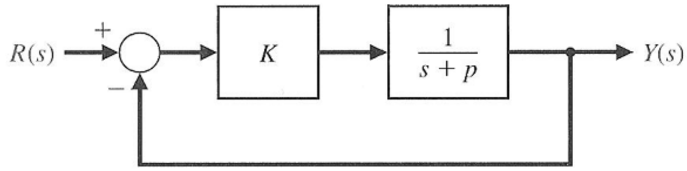
<u>Modern Control Systems   ELG 4157 / SYS 5100</u>

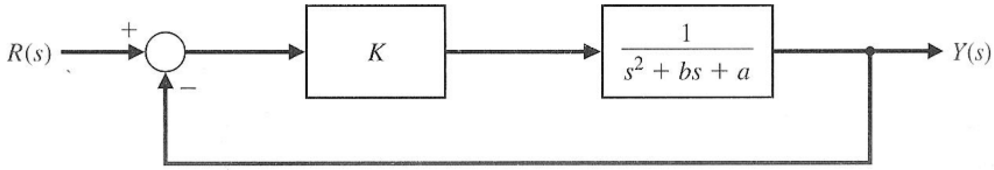
<u>MATLAB Assignment 2</u>

Q1) Consider the unity feedback control system given in the figure:



where the parameter *p* is a variable. By considering the nominal value of this variable to be $p=10$, and by using the Matlab functions of assignment 1, obtain a family of step responses of this system for $0.1 < p < 20$. Use $K = 5$ and verify with $p=10$ the system response has $P.O. < 5\%$ and $T_s=0.1$ *sec*.

Q2) Consider the unity feedback control system given in the figure:

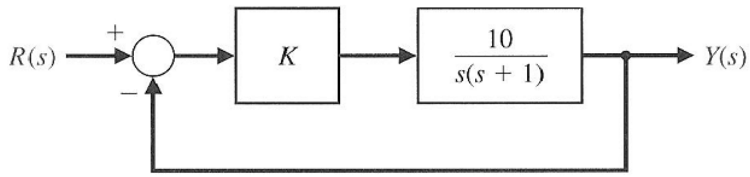


where the value of the parameter *a* is known and can be very precisely set to be $a=8$. However the exact value for parameter *b* is unknown but its nominal value can be set to be $b=4$.

(a) With these values for the parameters *a* and *b* and by using MATLAB functions **rlocus** and **rlocfind**, design the possible proportional controller *K* such that the closed-loop system response to a unit step input has a settling time with the 2% criterion to be less than 5 sec and an overshoot of less than 10%.

(b) With this designed value of *K* obtained above and with different values of parameter *b* which can be set to be $b = 0, 14,$ and 40, study the effects of these variations in the parameter *b* on the closed-loop system response to a step input by co-plotting the system response associated with each of those values of *b*.

Q3) Consider the unity feedback control system given in the figure:



Use Matlab functions **logspace**, **bode** and **semilog** to obtain a plot of the sensitivity function $|S_K^T|$ versus ω and co-plot the closed-loop transfer function | *T(s)* | versus ω.

Q4) A unity negative feedback loop has the loop transfer function *GH(s)*:

$$GH(s) = \frac{a(s-1)}{s^2 + 2s + 1}$$

where the parameter *a* can vary only between $0 < a < 1$, use **bode** and **margin** functions to develop a Matlab script to:

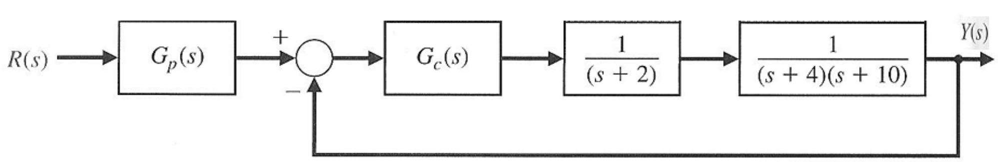
(a) plot the steady-state tracking error versus the parameter *a* to a negative unit step input given by (- $^1/_s$).

(b) plot the maximum % overshoot versus the parameter *a*.

(c) plot the gain margin versus the parameter *a*.

(d) Based on the plots obtained above, comment on the system robustness due to changes in the parameter *a*.

Q5) A certain system which is modeled by the block diagram shown in the figure:



Develop a Simulink simulation to study the system performance to a step input if a PID controller is selected such that:

$$G_c(s) = \frac{K_3(s^2 + as + b)}{s}$$

where K_3, a and b are design parameters and can be selected such that the dominant system's roots have damping ratio of 0.8 and the overshoot is less than 3%. Use the prefilter block $G_p(s)$ in the Simulink environment as $\frac{124.4}{den(s)}$.

Hint: In order to achieve the required performance determined by the required damping ratio and % overshoot, use root-locus methods to find out that $K_3 = 12.5$ and $b=10$ for a value of $a=6$.