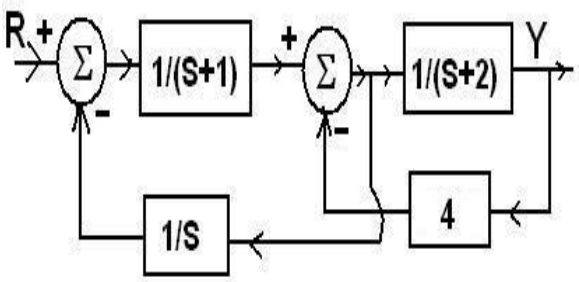
Name: ...
Id No.: ...

Eskişehir Osmangazi University - Electrical Engineering Department
Fundamentals of Control Systems
First Midterm Examination - Summer 2013

For each question, put the answer just below or next to it. Correct answers are sufficient for full credits.

1. For the figure below, find the polynomials $n(s)$ and $d(s)$ such that the transfer function from R to Y is $\frac{n(s)}{d(s)}$.



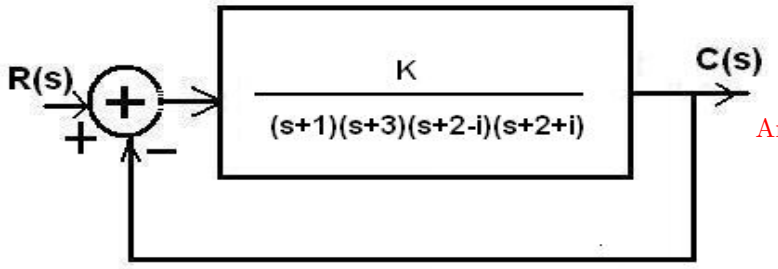
$n(s) = s$

$d(s) = s^3 + 7s^2 + 7s + 2$

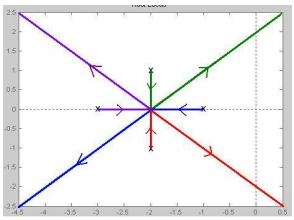
2. What is the maximum output value if $4u(t)$ is applied to the system with transfer function $G(s) = \frac{3}{(s+1)^2+6}$. The $u(t)$ stands for the unit step function.

Output under the $4u(t)$ can be written in the form: $\frac{4}{s} \times \frac{3}{7} \times \underbrace{\frac{7}{s^2+2s+7}}_{\text{standard part}} \rightarrow \xi = \frac{1}{\sqrt{7}}$. For the standard part, under the unit step input, the peak value is $1 + e^{\frac{-\xi\pi}{\sqrt{1-\xi^2}}} = 1.273$. For the overall system the peak value is $4 \times \frac{3}{7} \times 1.273 = 2.189$

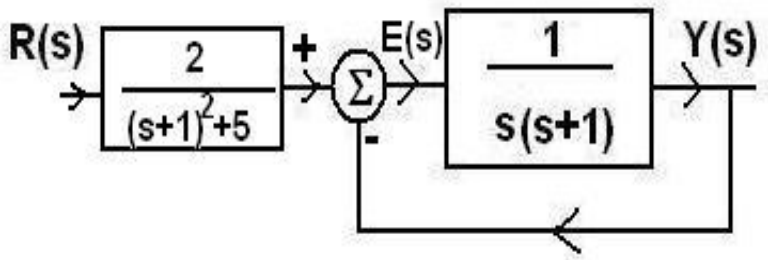
3. For the figure below, sketch the root locus. Find angle of departure(s), break-away point(s), asymptote's angle(s) and use them in the sketch.



Ans.



4. For the figure below, find the transfer function $\frac{E(s)}{R(s)}$, and steady state error e_{ss} for the unit step input.



$\frac{E(s)}{R(s)} = \frac{2}{(s+1)^2+5} \times \frac{s^2+s}{s^2+s+1}$
$= \frac{2s^2+2s}{(s^2+2s+6)(s^2+s+1)}$
$= \frac{2s^2+2s}{s^4+3s^3+9s^2+8s+6}$
$e_{ss} = \lim_{s\to 0} sE(s) = \lim_{s\to 0} s\frac{2}{(s+1)^2+5}\frac{s^2+s}{s^2+s+1}\frac{1}{s} = 0$

Good Luck,
A. Karamancıoğlu