

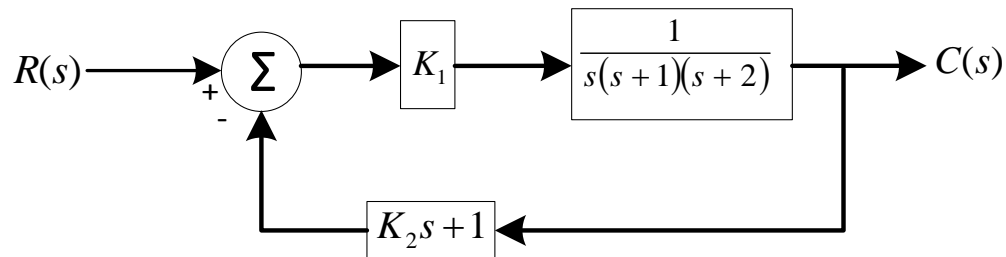
Portland State University  
Electrical & Computer Engineering  
ECE 311 Feedback & Control

-Midterm Practice Exam-

Students have 110 minutes to complete this exam. Write neatly, box answers, and show all calculations. This is an open-book, open-note exam.

Problem 1 (25 points) - Routh Stability Criterion

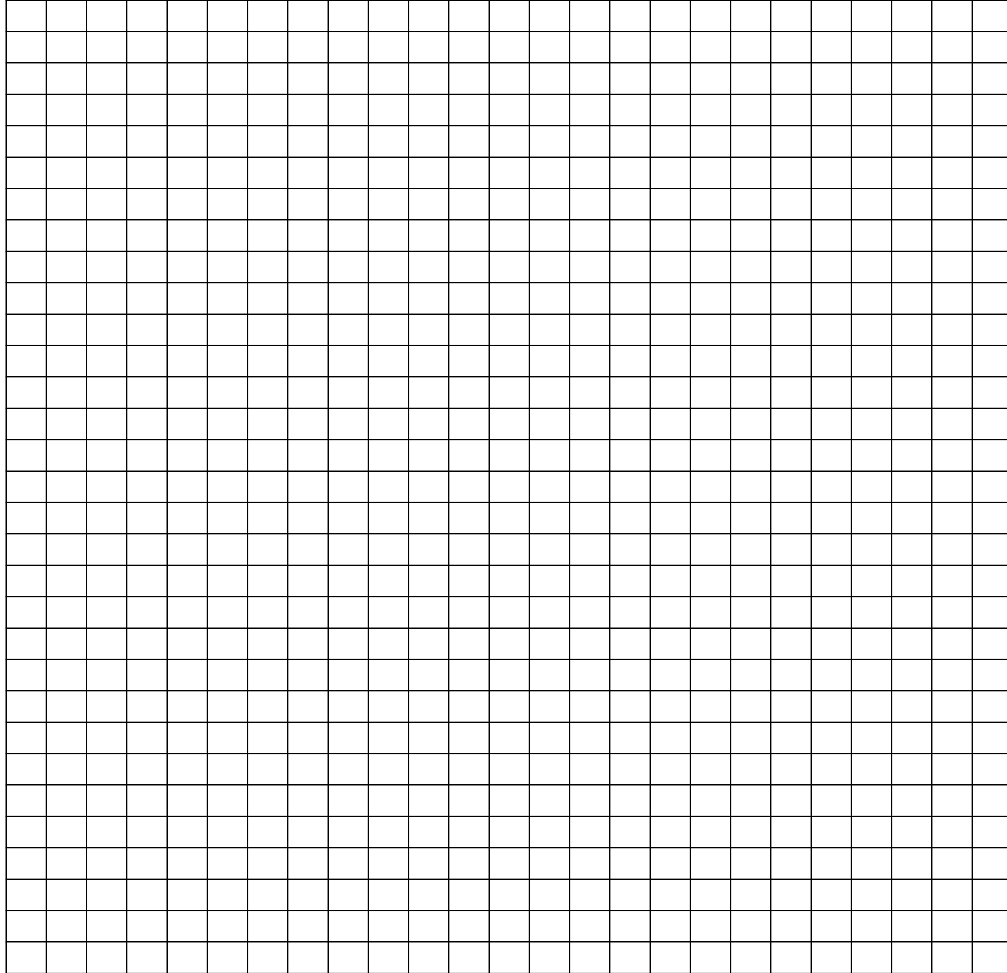
Consider the following closed-loop control system featuring derivative control within the feedback loop. Determine the constraints on  $K_1$  and  $K_2$  required for stability.



Problem 2 (25 points) – 2<sup>nd</sup>-Order Closed-Loop Transfer Functions

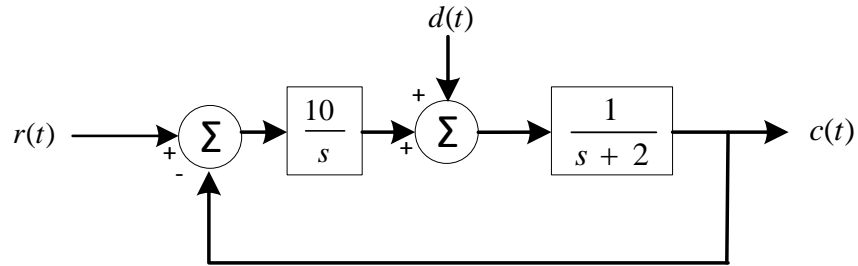
Plot the s-plane bounds on poles given the following time-domain specifications for a second-order closed-loop transfer function subject to a unit-step input.

$$t_r \geq 1.8 \text{ sec}, t_p \geq 8 \text{ sec}, M_p \leq 5\% (\xi \geq 0.69), t_s \leq 9 \text{ sec } (\pm 1\%)$$



Problem 3 (25 points)

Consider the following control system block diagram with a reference input  $r(t)$  and a disturbance input  $d(t)$ .



1. Draw the block diagrams and state the transfer functions for both  $C_R(s)/R(s)$  and  $C_D(s)/D(s)$ .
2. Determine the percent overshoot, peak time, rise time (10% to 90%) and settling time ( $\pm 5\%$ ) for these functions.
3. Determine the DC gain for the reference and disturbance inputs. Then discuss the significance of these gains with respect to one another.

Problem 4 (25 points) - Difference Equation Emulation

Find the difference equation corresponding to the controller  $C(s)$  in the following block diagram.

