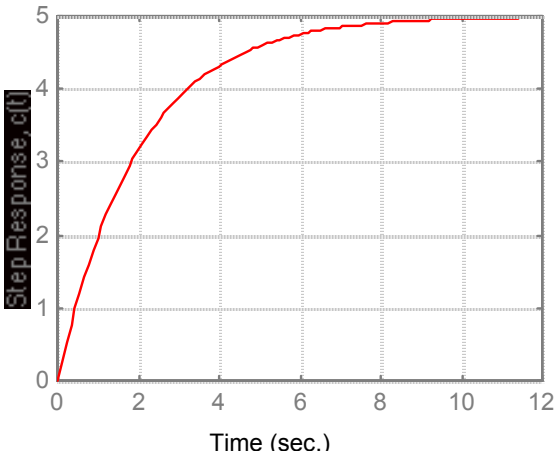
1.) A plant has the response, $y(t)$, to a unit step, $x(t) = u(t)$ as shown below.





(15 pts) a) Estimate the system's time constant, 2% settling time and steady state gain. (Write results in boxes below)

Time Constant (sec) | 2% Settling Time | Steady-State Gain

(5 pts) b) What is the minimum order is the system transfer function based on the characteristics of the time response? (Write your result in the box provided)

Minimum System Order

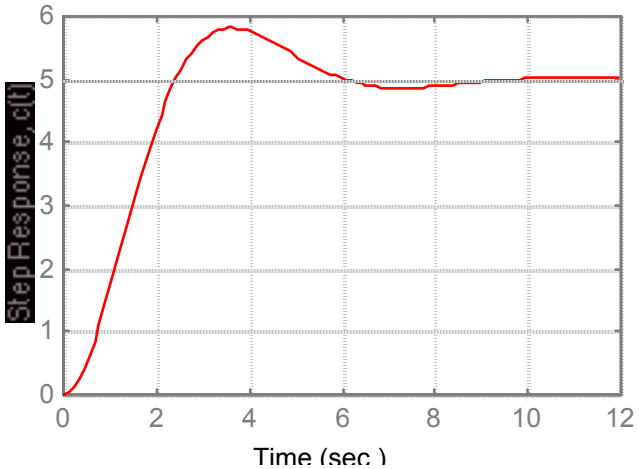
(5 pts) c) For a system model of the minimum order in part b), Find the transfer function $G(s) = Y(s)/X(s)$ (Write your result in the box provided)

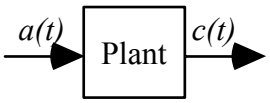
$G(s) =$

Transfer Function

_____/25

2.) A plant has the response, *c(t)*, to a unit step, *a(t) = u(t)* as shown below.





(15 pts) a) From the graph, estimate the system's time constant, 2% settling time, % overshoot and steady state gain. (Write results in boxes below)

Time Constant (sec) | % Overshoot | Steady-State Gain

(10 pts) b) Compute an estimate of the system's damped natural frequency and damping ratio.

Damped Natural Freq (rad/sec) | Damping Ratio

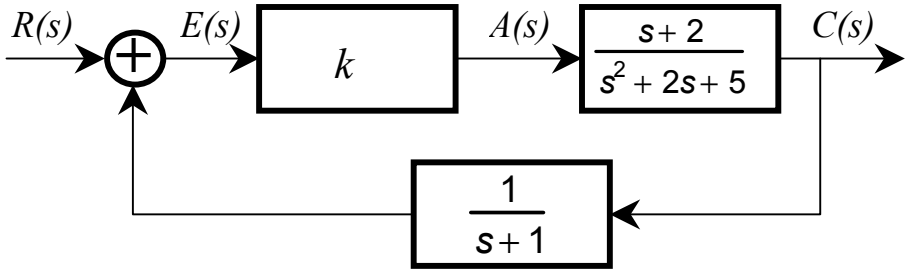
(5 pts) c) Using the above information, find the second order transfer function *G(s) = Y(s)/X(s)* (Write your result in the box provided)

G(s) =

Transfer Function

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3. For a controlled plant with Proportional controller shown below,



(5 pts) a) What is the closed-loop system characteristic polynomial?

Closed-Loop Characteristic Polynomial

(5 pts) b) What is the closed-loop error transfer function, *E(s)/R(s)* ?

$\frac{E(s)}{R(s)} =$

Closed-Loop Error Transfer Function

(5 pts) c) What is the system's <u>closed-loop</u> steady-state error at k=1?

$e(\infty) =$

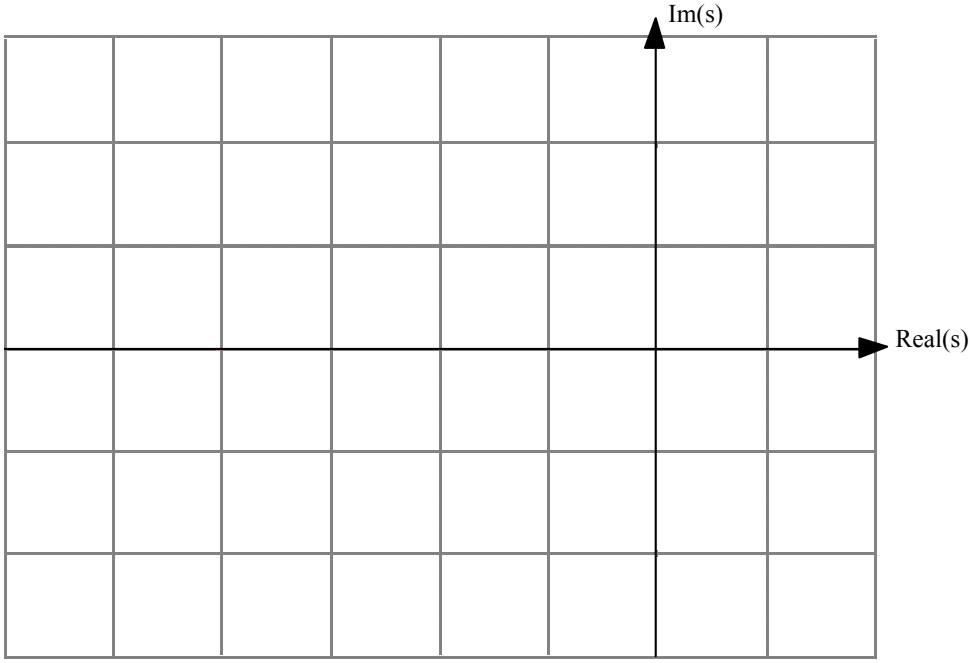
Closed-Loop System Steady-State Error at k = 1

(10 pts) d) For what range of gain *k* is the system stable?

Range of stable gain *k*

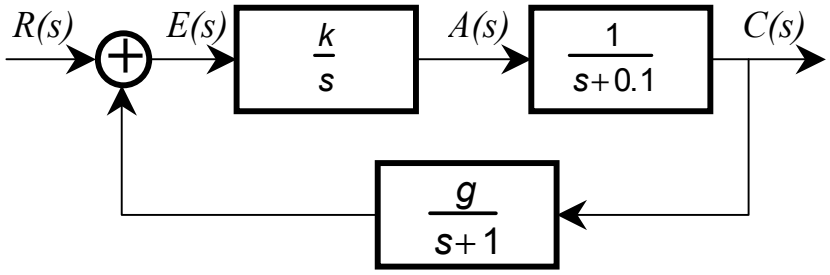
_____/10

(10 pts) 3 e) Draw the root locus for $k \geq 0$ noting were possible, range of stable gain, breakaway/breakin points, angles of departure/arrival, asymptotes, etc.



_____/10

4. A designer proposes an automotive speed control with the feedback structure,



(5 pts) a) What is the new system's closed-loop steady-state error at k=1, g=1?

$e(\infty) =$

Closed-Loop System Steady-State Error at k = 1

(10 pts) b) What is the steady-state sensitivity of the speed control system's response to changes in the speed sensor gain, *g*?

Steady-State Sensivity to changes in g

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