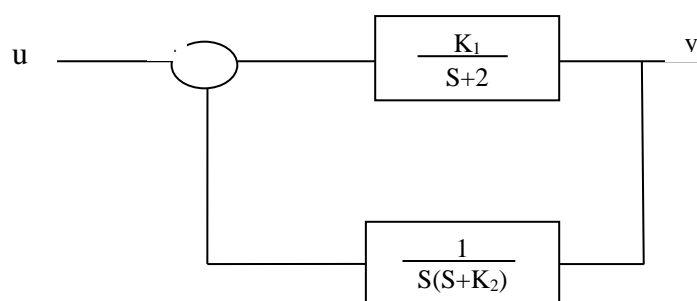


## SHEET 3

### Error Analysis and Routh Stability

1. For the system shown in figure, find the conditions on  $K_1$  and  $K_2$  to make the system stable. Plot the region of stability for  $K_1$  and  $K_2$ .



2. A unity feedback system has a forward transfer function of:

$$G(s) = \frac{12(s+4)}{s(s+1)(s+3)(s^2+2s+10)}$$

- Determine the static error coefficients for this system.
- Determine the steady state error and the steady state output for a reference input  $r(t) = 16+2t$  and for  $r(t) = 5t^2$ .
- Is the closed loop system stable?

3. A unity feedback control system has the forward transfer function:

$$G(s) = \frac{k_v}{s(4s+1)(s+1)}$$

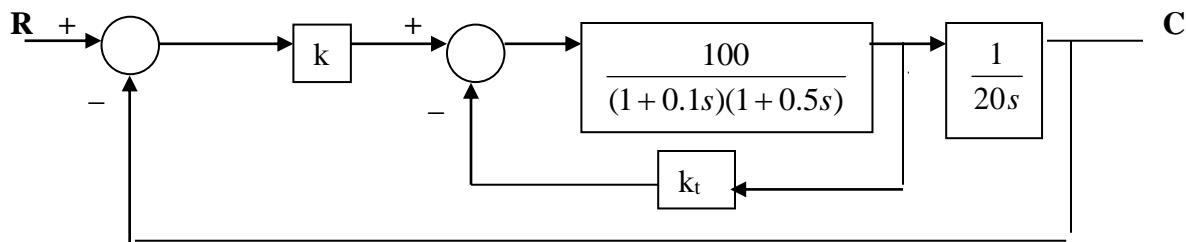
- The steady state value of the error is desired to be less than or equal to 0.1 for a reference input  $r(t) = 1+t$ . Determine the minimum value of  $k_v$  that satisfies this requirement.
- Check the stability of the system for the value  $k_v$  of obtained in part (a) and comment on your result.

4. The block diagram of a control system is shown the following figure. Find the step, ramp and parabolic error constants. The error signal is defined to be  $e(t)$ . Find the steady state errors of the system in terms of  $k$  and  $k_t$ , when the following inputs are applied:

a)  $r(t) = 6 + 8t$

b)  $r(t) = 2t + 7t^2$

What constraint must be made on the values of  $k$  and  $k_t$  so that the answers are valid? Determine the minimum steady state error that can be achieved with a unit ramp input.



5. The block diagram of a feedback control system is shown in the figure. The error signal is defined to be  $e(t)$ .

a) Find the steady state error of the system in terms of  $k$  and  $k_t$  when the input is a unit ramp function. Give the constraints on the values of  $k$  and  $k_t$  so that the answer is valid.

