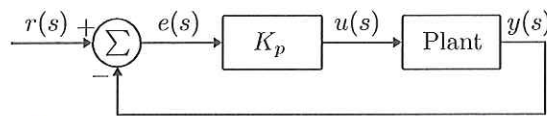# Test: Introduction to Control

1. Write an expression for the closed-loop transfer function of the system shown below.
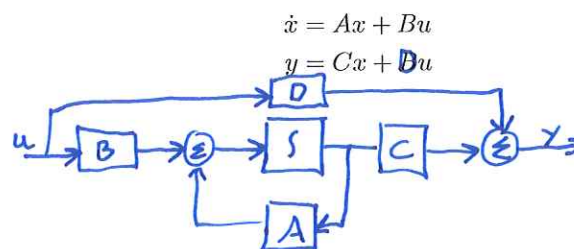

Let the transfer function of the plant be $G(s)$. Then
$$\begin{cases} Y(s) = G(s) k_p e(s) \\ e(s) = r(s) - y(s) \end{cases} \checkmark$$
$$Y(s) = G(s) k_p (r(s) - y(s))$$
$$(1 + G(s) k_p) y(s) = G(s) k_p r(s) \implies \frac{Y(s)}{r(s)} = \frac{G(s) k_p}{1 + G(s) k_p}$$

2. Draw a block diagram of the state space model

$$\dot{x} = Ax + Bu$$
$$y = Cx + Du$$

3. What is the steady state error (if any) of the following system subject to a ramp input

$$T(s) = \frac{y(s)}{r(s)} = \frac{s}{s+2}$$

We use the Final Value Theorem and study

$$s \frac{s}{s+2} \cdot \frac{1}{s^2}\Big|_{s=0} = \frac{s^2}{s^2(s+2)}\Big|_{s=0} = \frac{1}{s+2}\Big|_{s=0} = \frac{1}{2}$$

Consequently, $Y(s) = \frac{1}{2} r(s)$ and we get a steady state error of $\frac{1}{2}$

4. Draw a block diagram of a plant $G(s)$ with feedback controller $K(s)$ and feedforward given by $F(s)$.

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