Lecture: Block Diagram Reduction and Mason’s Rule

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Block-Diagram Reduction

(a). Cascaded subsystems;
(b). Equivalent transfer function.

\[ X_2(s) = \frac{X_1(s)}{G_1(s)} R(s) \]

\[ X_1(s) = \frac{G_2(s) G_1(s)}{G_3(s) G_2(s) G_1(s)} R(s) \]

\[ C(s) = \frac{G_3(s) G_2(s) G_1(s)}{G_3(s) G_2(s) G_1(s)} R(s) \]
Block-Diagram Reduction

\[ X_1(s) = R(s)G_1(s) \]
\[ X_2(s) = R(s)G_2(s) \pm \]
\[ X_3(s) = R(s)G_3(s) \]

\[ C(s) = [\pm G_1(s) \pm G_2(s) \pm G_3(s)]R(s) \]

(a)

\[ R(s) \]
\[ \pm G_1(s) \pm G_2(s) \pm G_3(s) \]
\[ C(s) \]

(b)

- Parallel subsystems;
- Equivalent transfer function.
Feedback Control System and Simplified Model

(a)

(b)
Equivalent Transfer Function

\[ \frac{G(s)}{1 \pm G(s)H(s)} \]
Convert a block diagram to a signal-flow graph

Step 1: signal nodes:

\[ R(s) \quad V_1(s) \quad V_2(s) \quad V_3(s) \quad V_4(s) \quad V_5(s) \quad V_6(s) \quad V_7(s) \quad V_8(s) \quad C(s) \]
Step 2: Signal-flow graph
Step 3: Simplified signal-flow graph