

Block Diagram Reduction Rules

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MECHANICAL ENGINEERING DEPARTMENT

MEE 503 Control Systems Engineering
 AY 2019—2020

NAME: _____

SCORE: _____

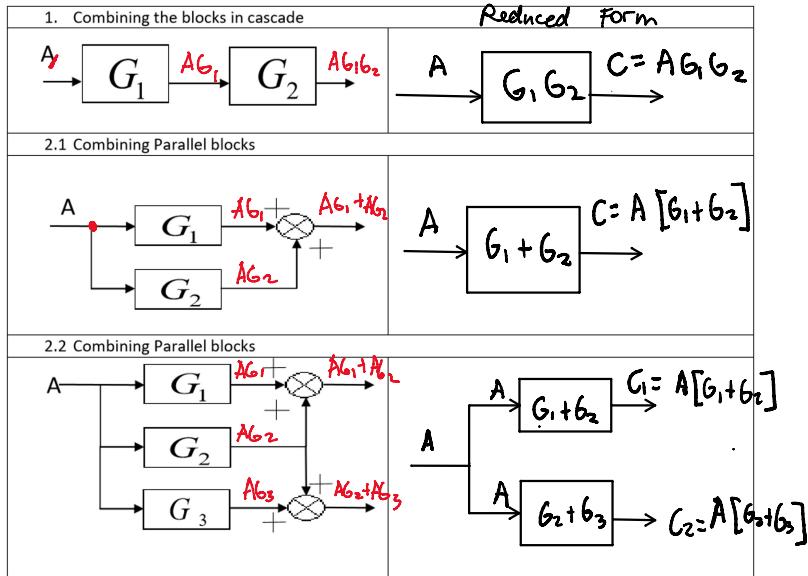
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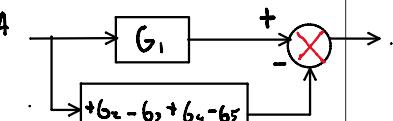
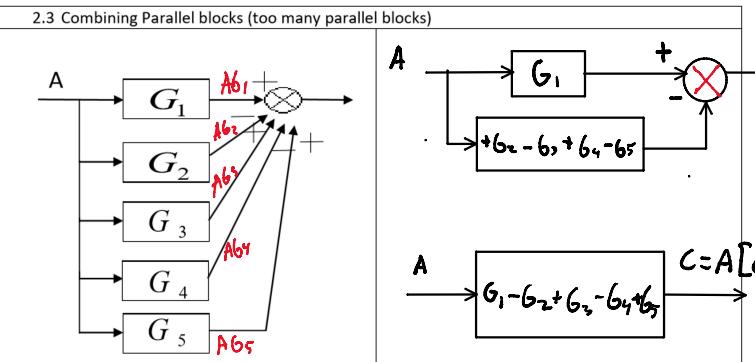
DATE: _____

SECTION: _____

I. Block Diagram Basic Rules

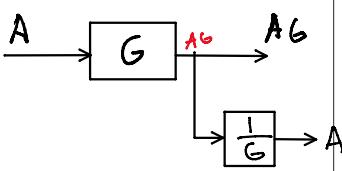
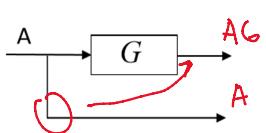
Draw the equivalent diagram and identify the output of each block diagram.



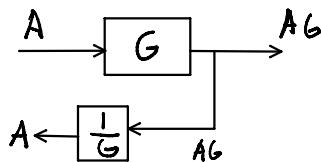
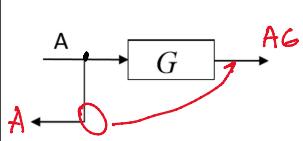


$$C = A[G_1 - G_2 + G_3 - G_4 + G_5]$$

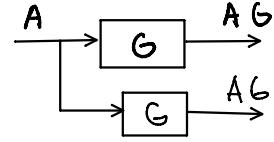
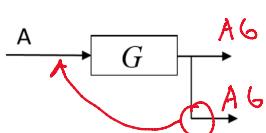
3.1 Moving the Branch point ahead of the block



3.2 Moving the Branch point ahead of the block



4.1 Moving the Branch point before the block

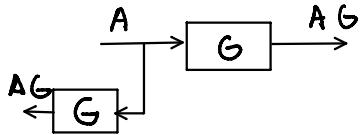
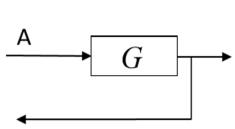


X is unknown

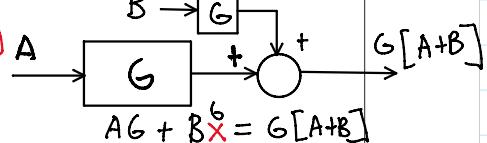
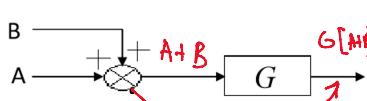
$$AG \cdot X = A$$

$$X = \frac{1}{AG}$$

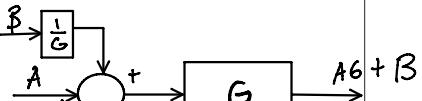
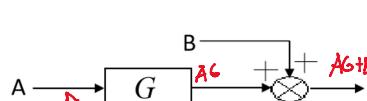
4.2 Moving the Branch point before the block



5. Moving summing point ahead of the block

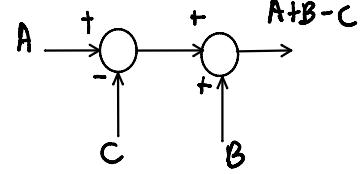
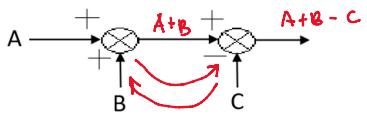


6. Moving summing point before the block

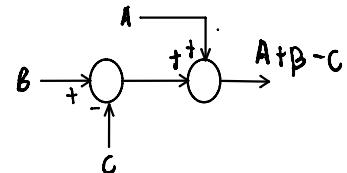
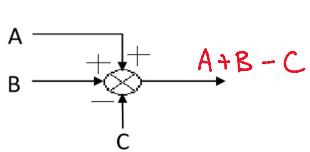


$$[A + Bx] \times G = AG + B$$

7. Swap with 2 neighboring summing points

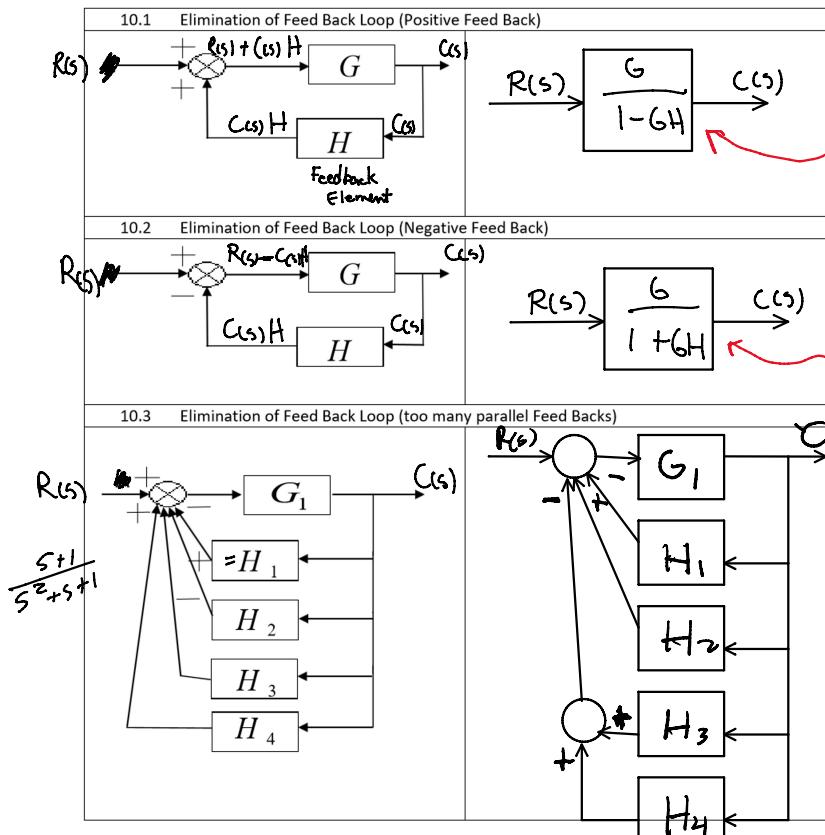


8. Splitting summing points / combining summing points

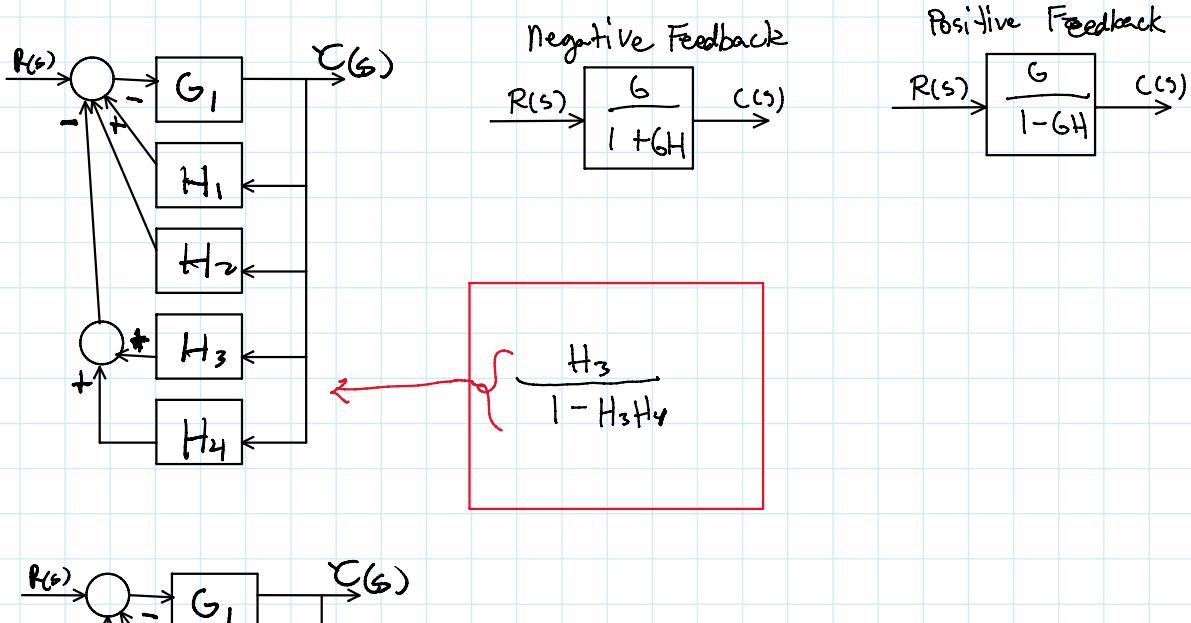


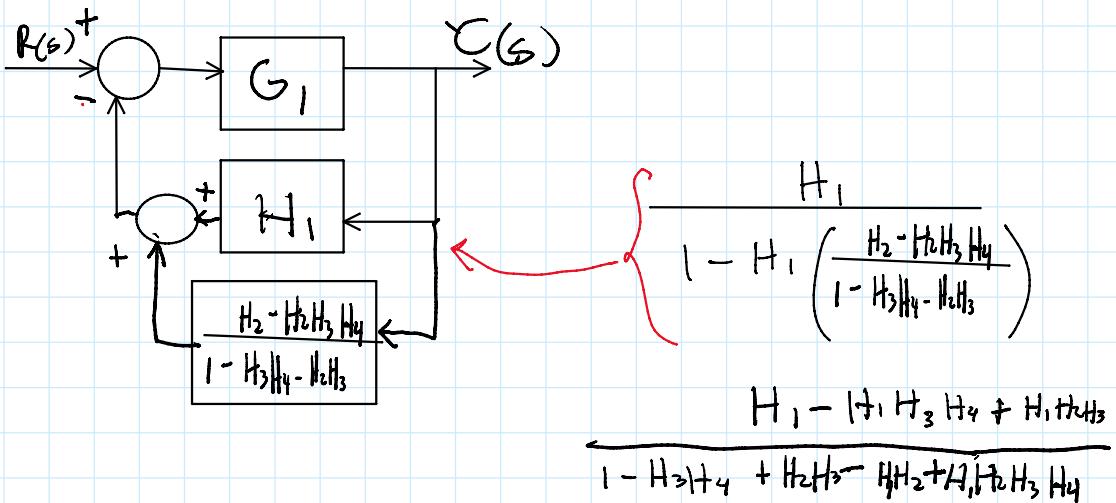
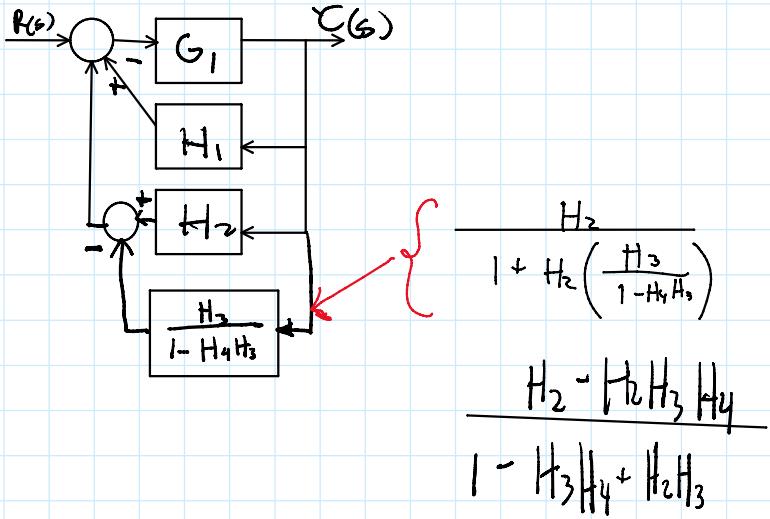
X = is unknown

$$G = \frac{C(s)}{R(s)}$$



$$\begin{aligned}
 R(s) &\xrightarrow{\text{Sum}} e(s) = R(s) - C(s) \xrightarrow{\text{G}_1} C(s) \\
 &= (1 - H_3)H_4 + H_2H_3 - HH_2 + H_1H_2H_3H_4 \\
 R(s) &\xrightarrow{\text{Sum}} e(s) = R(s) - C(s) \xrightarrow{\text{G}_1} C(s) \\
 &= 1 - H_3H_4 + H_2H_3 - HH_2 + H_1H_2H_3H_4 + G(H_1 - H_1H_3H_4 + H_1H_2H_3)
 \end{aligned}$$





$$\frac{G_1}{1 - G_1 \left(\frac{H_1 - H_1 H_3 H_4 + H_1 H_2 H_3}{1 - H_3 H_4 + H_2 H_3 - H_1 H_2 + H_1 H_2 H_3 H_4} \right)}$$