

CASCADED MODULATORS

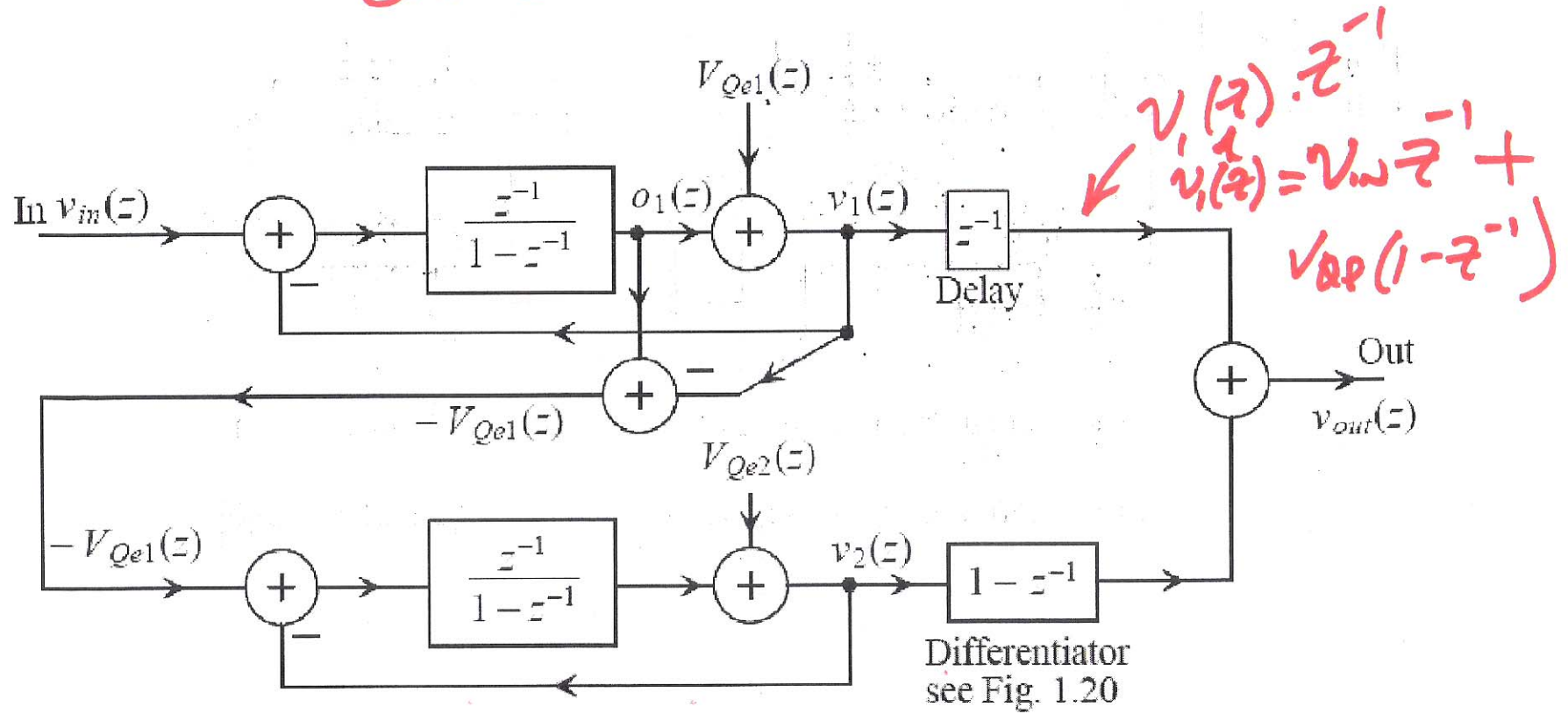


Figure 7.53 Second-order (1-1) cascaded modulator.

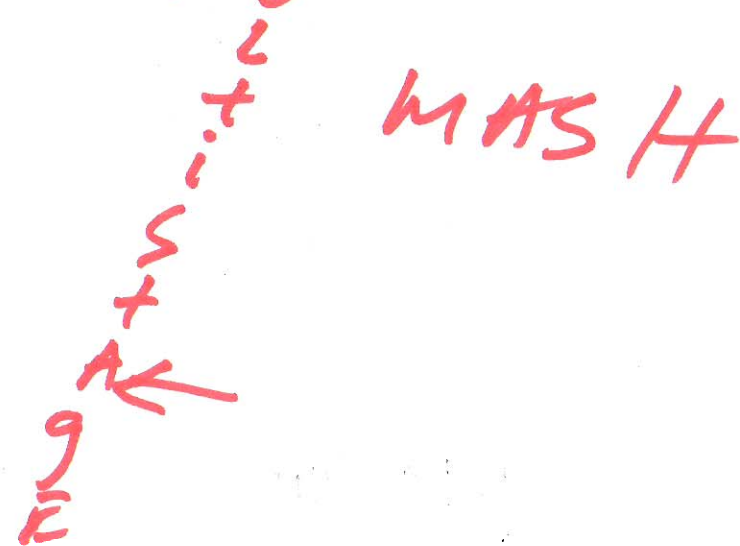
$$(1-z^{-1})(v_2(z)) = \left(-V_{Qe1}(z)z^{-1} + V_{QP}(z)(1-z^{-1}) \right)$$

1)

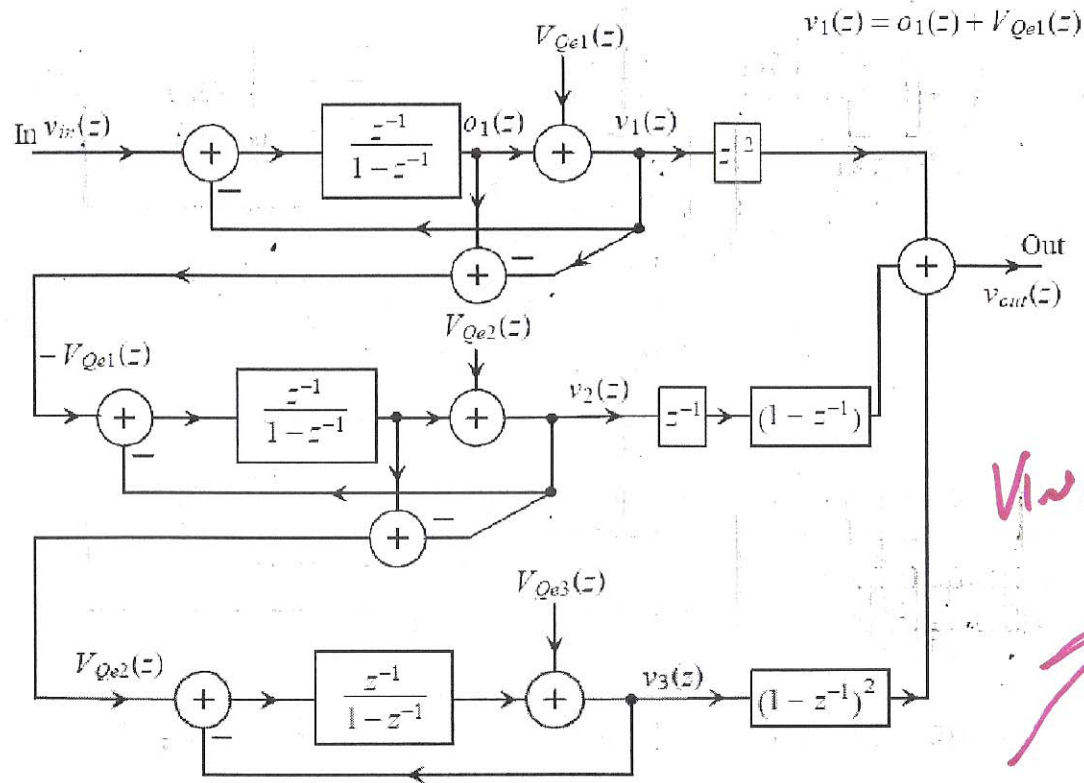
$$\begin{aligned}
 V_{out}(z) &= V_{in}z^{-2} + z^{-1}(1-z^{-1})V_{oe1}(z) \\
 &+ (1-z^{-1})z^{-1}(-V_{oe}(z)) + (1-z^{-1})V_{oe}(z)(1-z^{-1}) \\
 &= V_{in}z^{-2} + (1-z^{-1})^2V_{oe}(z)
 \end{aligned}$$

second-order
noise shaping

1 - 1 MAS HAPing



2)



1-1-1

$$v_{out}(z) z^{-3} (1-z^{-1})^3 v_{ae}$$

Figure 7.54 Third-order (1-1-1) cascaded modulator.

$$v_{out}(z) = z^{-3} \left(z^{-1} v_m(z) + v_{ae1}(z)(1-z^{-1}) + z^{-1}(1-z^{-1}) \left(z^{-1} v_{ae1}(z) + v_{ae2}(z)(1-z^{-1}) \right) + (1-z^{-1})^2 \left(v_{ae2}(z) \left(z^{-1} \right) + v_{ae3}(z)(1-z^{-1}) \right) \right)$$

3)

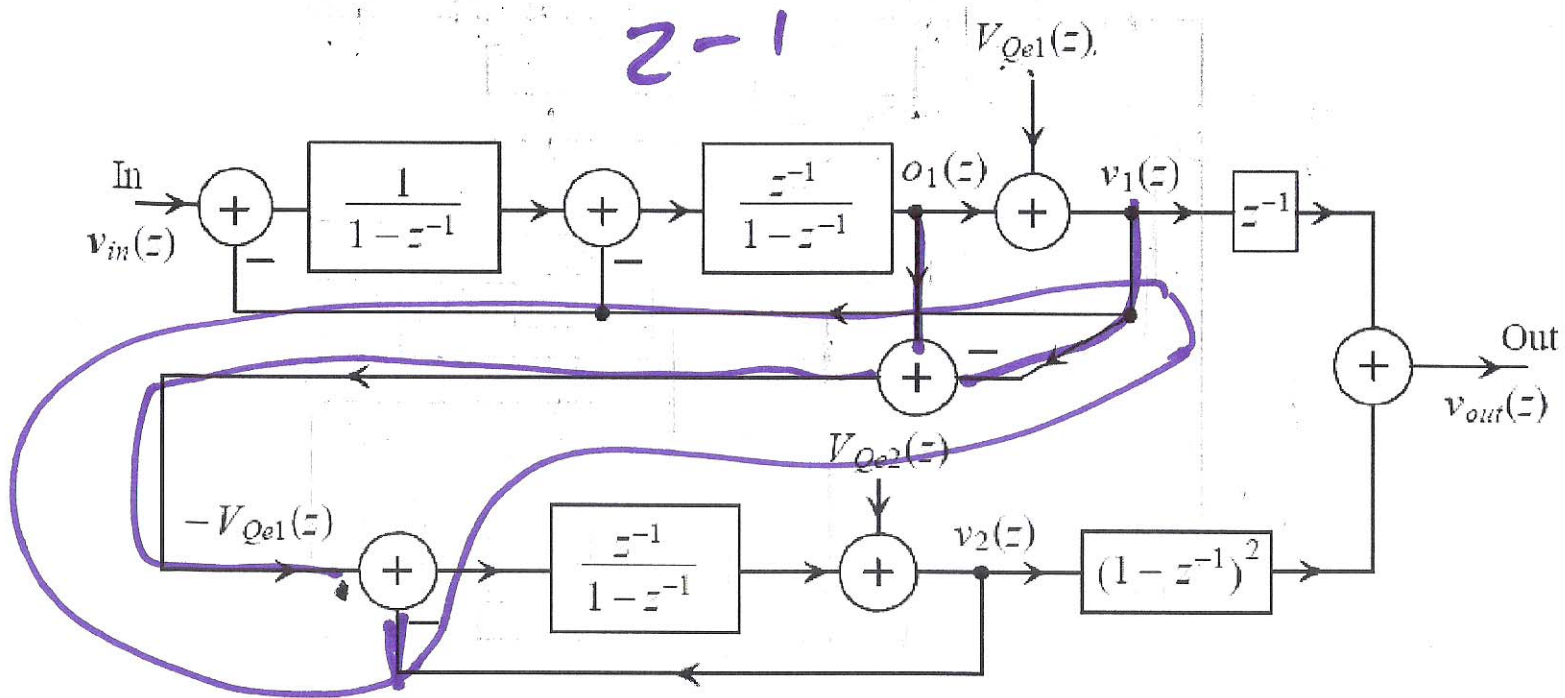


Figure 7.55 Third-order (2-1) cascaded modulator.

$$\begin{aligned}
 v_{out}(z) &= v_{in}(z) \cdot z^{-2} + \cancel{z^{-1}(1-z^{-1})^2 V_{Qe1}(z)} \\
 &+ \cancel{(1-z^{-1})^2 z^{-1} (-V_{Qe1}(z))} + V_{Qe2}(1-z^{-1})^3 \\
 &= v_{in}(z) z^{-2} + V_{Qe2}(1-z^{-1})^3
 \end{aligned}$$

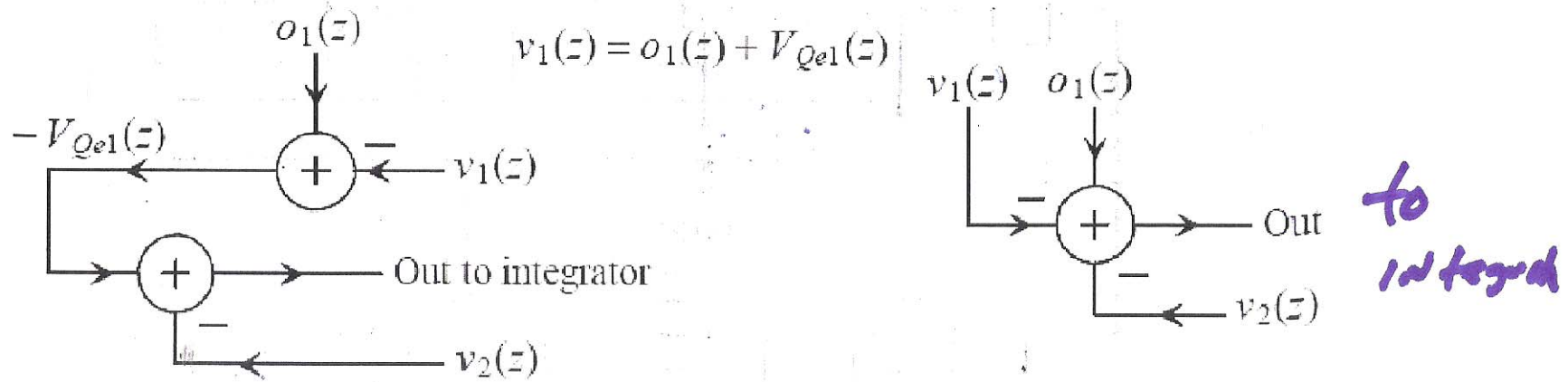


Figure 7.56 Showing implementation of the dual summing block as a single block.

5)

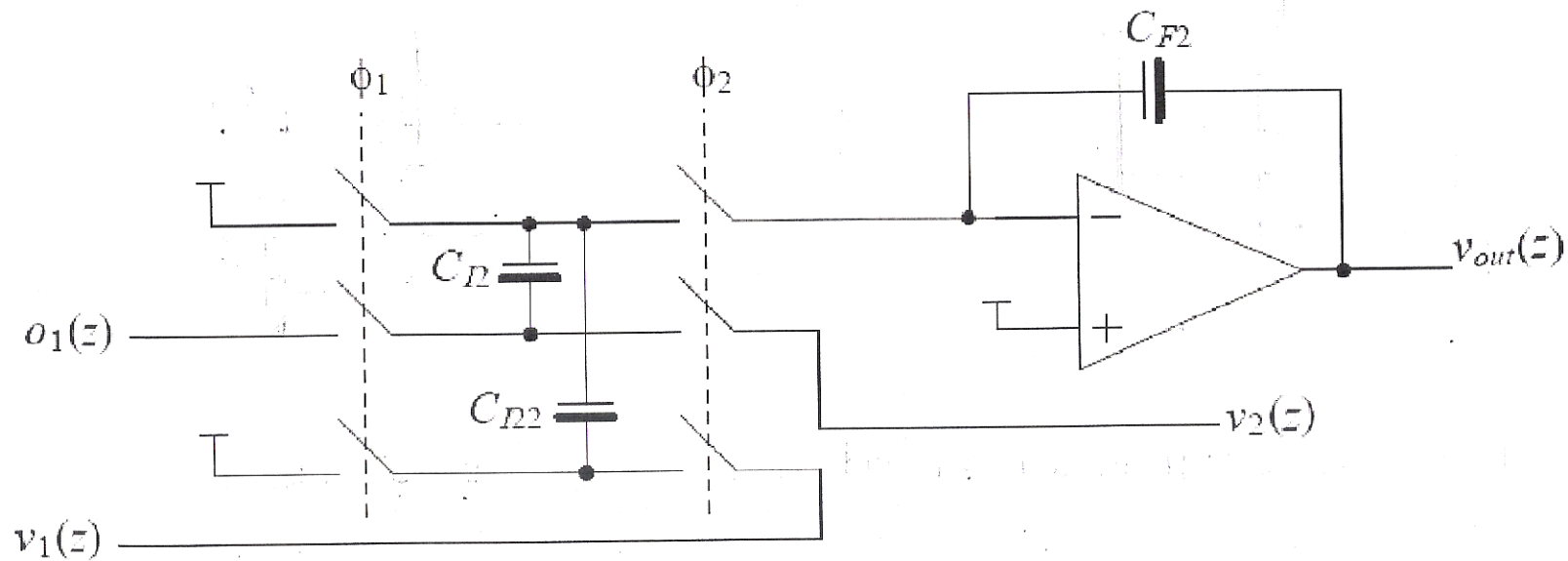


Figure 7.57 Implementing the dual summing block for a cascaded modulator.

b)