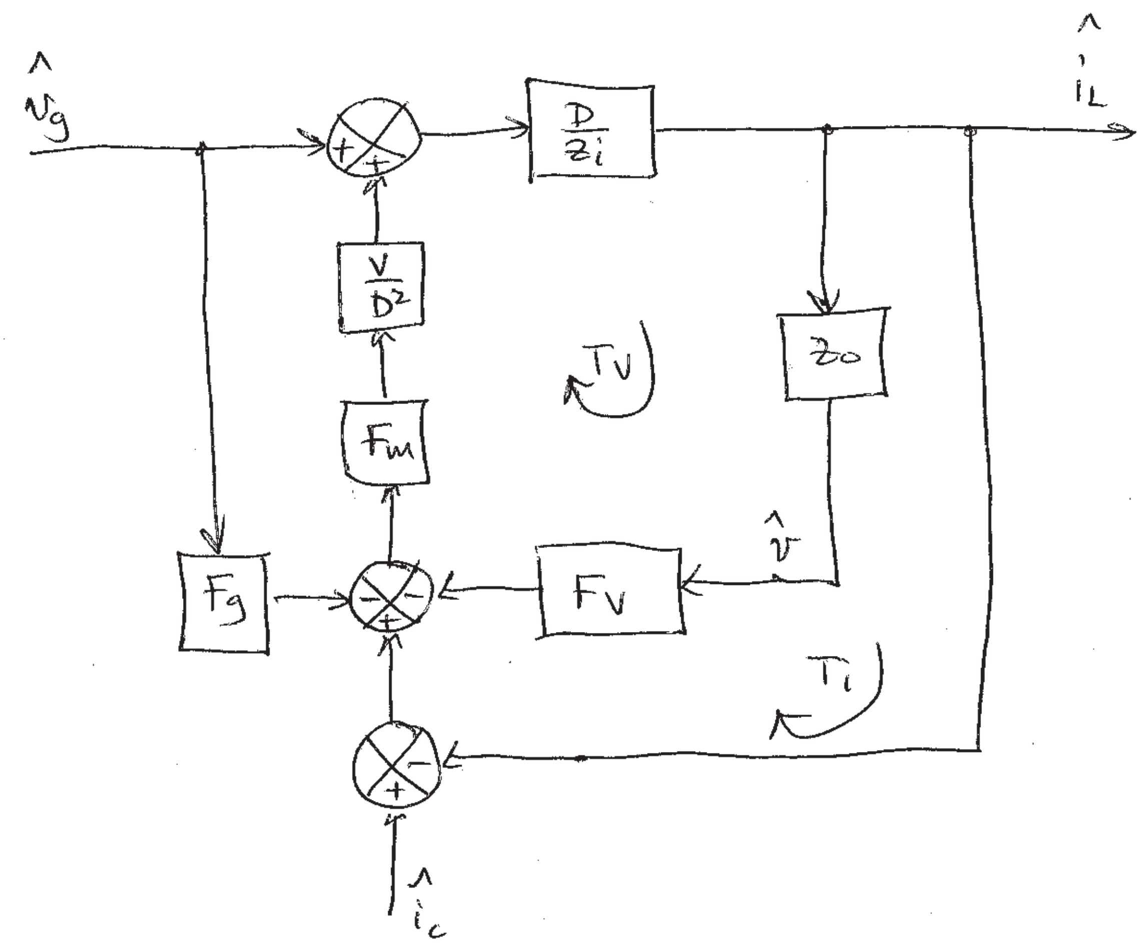
Derivation of line-to-output transfer function, p. 437, Eqs. (11.84) and (11.85)

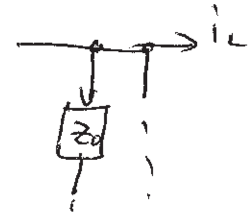
RWErickson

Fig. 11.26



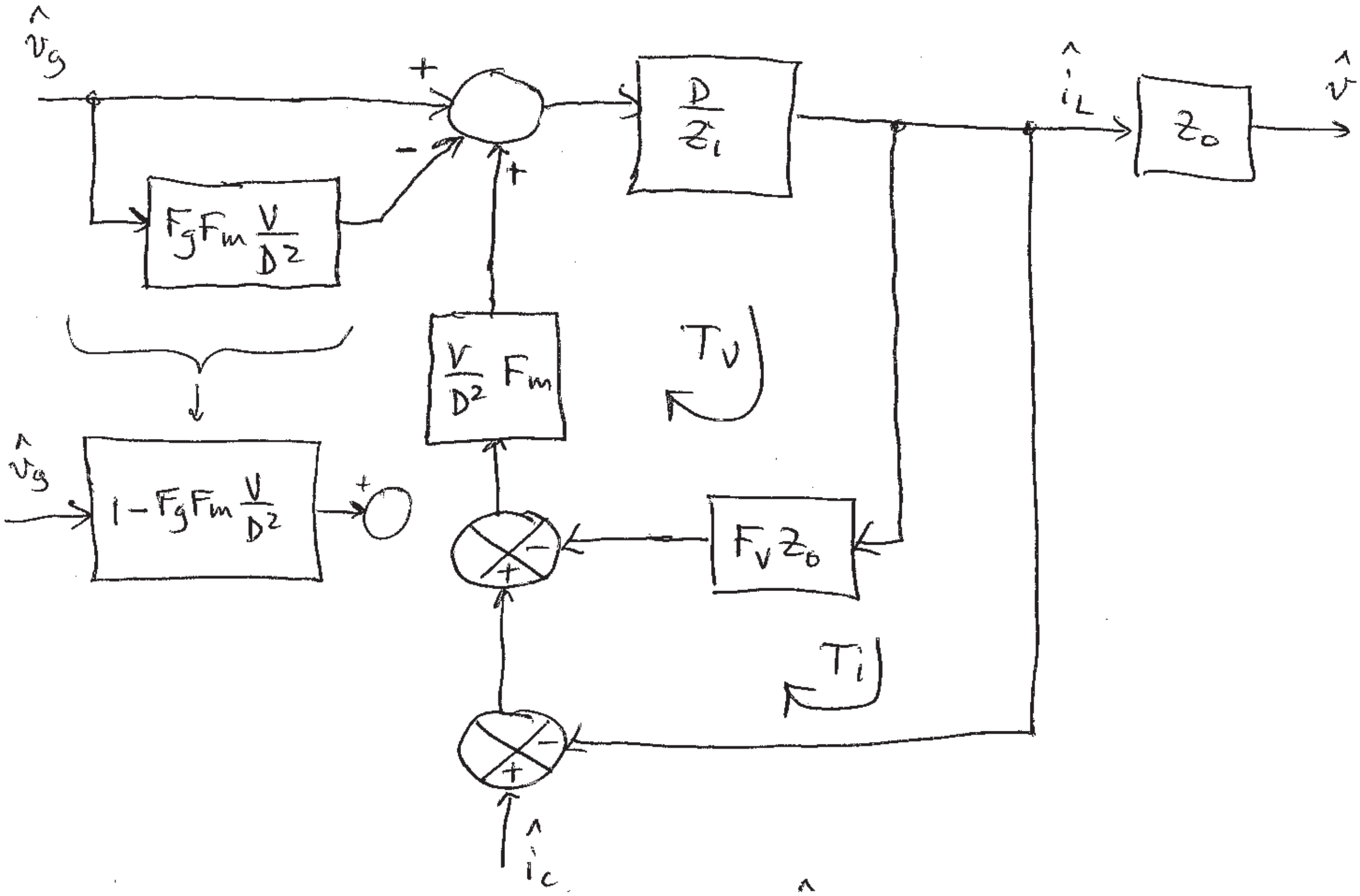
one method: manipulate $\hat{v}_g$ so it appears as a disturbance (see section 9.2.1 and Fig 9.4(b))

$\Rightarrow$ push $\hat{v}_g$ blocks so the $\hat{v}_g$ signal comes in near the output (at the pickoff point

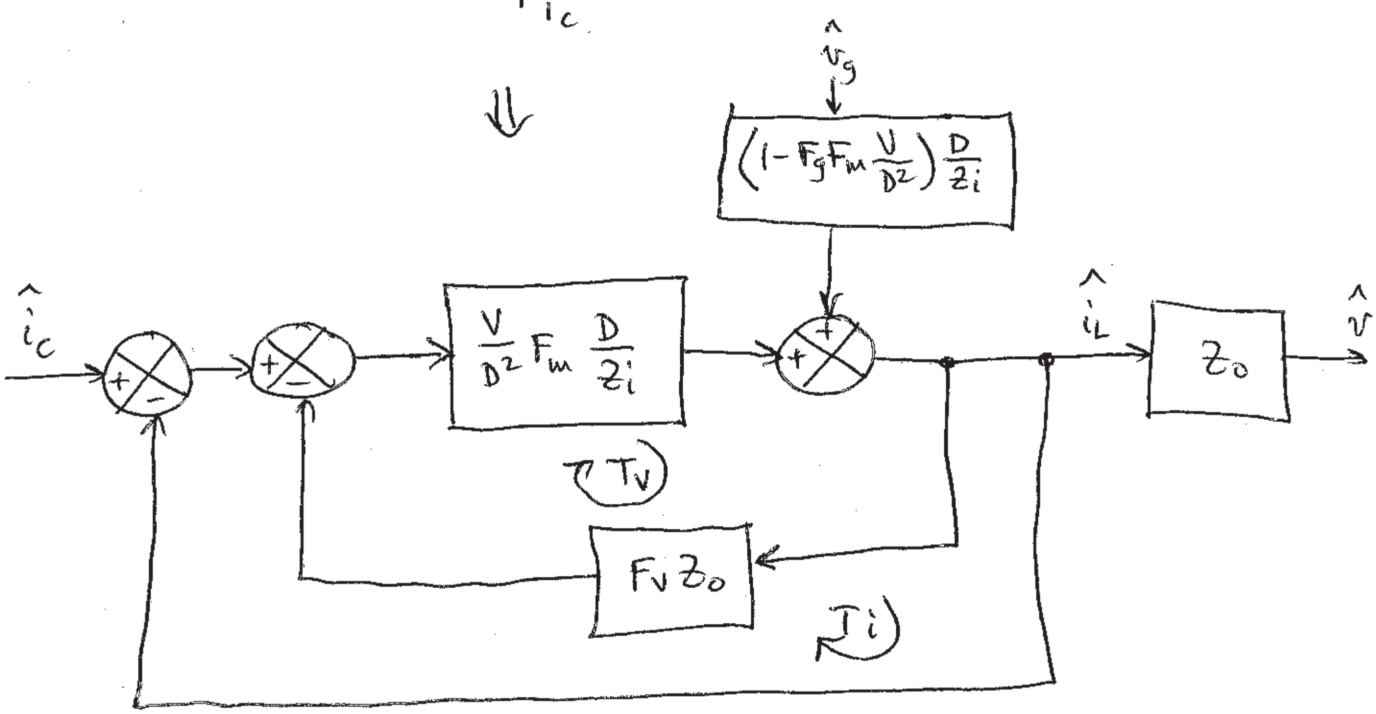


)

push the F_g path upwards;



$\Downarrow$



so $\dfrac{\hat{v}}{\hat{v}_g} = \left(1 - F_g F_m \dfrac{V}{D^2}\right) \dfrac{D}{Z_i} \cdot Z_o \cdot \dfrac{1}{1+T_v} \cdot \dfrac{1}{1+T_i} = \dfrac{G_{go}}{1+T_i}$

with $T_v = \dfrac{V}{D^2} F_m \dfrac{D}{Z_i} F_v Z_o$, $T_i = \dfrac{1}{F_v Z_o} \dfrac{T_v}{1+T_v}$

The disturbance $\hat{v}_g$ enters at a summing node that is internal to both the T_v and T_i loops.

Hence,
$$\frac{\hat{v}}{\hat{v}_g} = \underbrace{\left(1 - F_g F_m \frac{V}{D^2}\right) \frac{D}{Z_i} Z_o}_{\text{gain when } T_i \to 0 \text{ and } T_v \to 0} \cdot \frac{1}{1+T_v} \cdot \frac{1}{1+T_i}$$

In Eqs. (11.84) and (11.85), this transfer function is written as

$$\frac{G_{go}}{1+T_i}$$

with
$$G_{go} = \frac{\left(1 - F_g F_m \frac{V}{D^2}\right) \frac{D}{Z_i} Z_o}{1 + T_v}$$