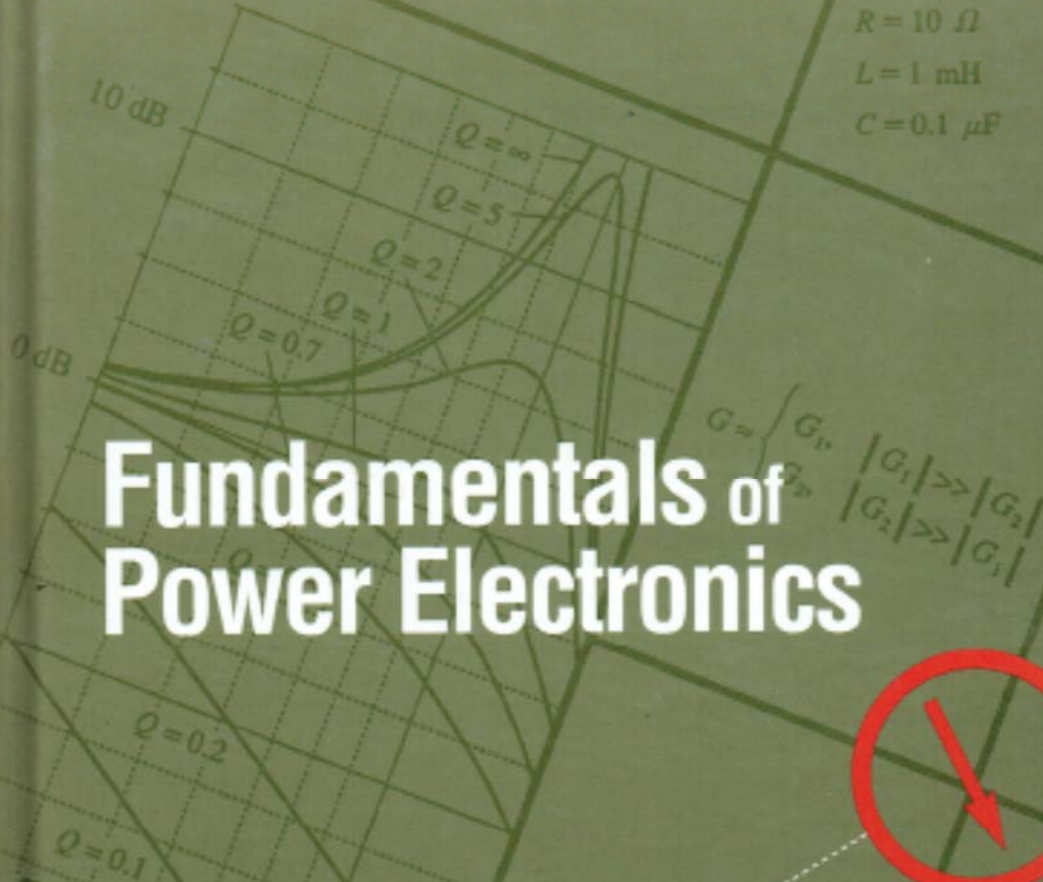


Robert W. Erickson

$$R = 10 \Omega$$

$$L = 1 \text{ mH}$$

$$C = 0.1 \mu\text{F}$$



# Fundamentals of Power Electronics

$$G = \begin{cases} G_1 & |G_1| \gg |G_2| \\ G_2 & |G_2| \gg |G_1| \end{cases}$$

$$s_1 = -\frac{a_1}{2a_2} \left[ 1 - \sqrt{1 - \frac{4a_2}{a_1^2}} \right]$$

$$G(s) = \frac{1}{(1 - \frac{s}{s_1})(1 - \frac{s}{s_2})}$$

$$\begin{aligned} f_0 &= f_0 e^{-\pi/2} = \frac{f_0}{4.81} \\ f_b &= f_0 e^{\pi/2} = 4.81 f_0 \end{aligned}$$



# Fundamentals of Power Electronics

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Thus, we have two unknowns,  $V$  and  $D_2$ , and we have two equations. The first equation, Eq. (5.19), was obtained by inductor volt-second balance, while the second equation, Eq. (5.27), was obtained using capacitor charge balance. Elimination of  $D_2$  from the two equations, and solution for the voltage conversion ratio  $M(D_1, K) = V/V_g$ , yields

$$\frac{V}{V_g} = \frac{2}{1 + \sqrt{1 + \frac{4K}{D_1^2}}} \quad (5.28)$$

where  $K = 2L/RT_g$   
valid for  $K < K_{crit}$

This is the solution of the buck converter operating in discontinuous conduction mode.

The complete buck converter characteristics, including both continuous and discontinuous conduction modes, are therefore

$$M = \begin{cases} D & \text{for } K > K_{crit} \\ \frac{2}{1 + \sqrt{1 + \frac{4K}{D^2}}} & \text{for } K < K_{crit} \end{cases} \quad (5.29)$$

where the transistor duty cycle  $D$  is identical to the subinterval 1 duty cycle  $D_1$  of the above derivation. These characteristics are plotted in Fig. 5.11, for several values of  $K$ . It can be seen that the effect

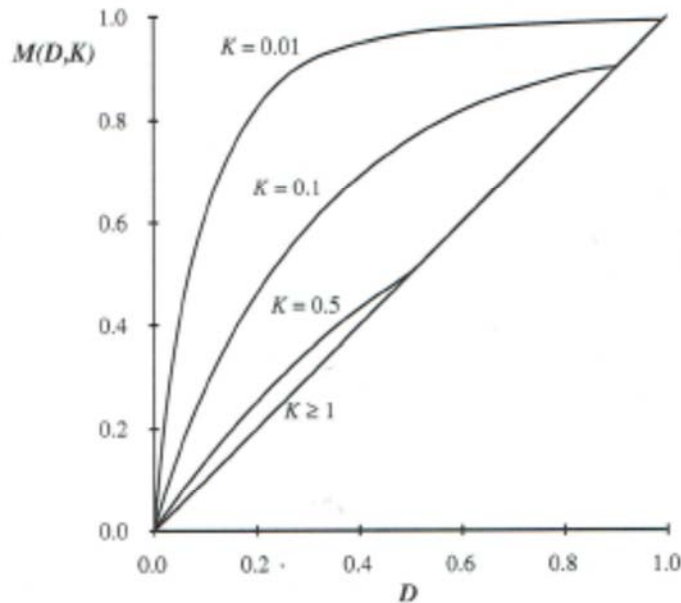


Fig. 5.11 Voltage conversion ratio  $M(D, K)$ , buck converter.