4.7 The buck–boost converter of Fig. 4.85 is implemented with a MOSFET and a p–n diode. The MOSFET can be modeled as ideal, but the diode exhibits a substantial reverse-recovery process, with reverse recovery time t_r and recovered charge Q_r. In addition, the inductor has winding resistance R_L. The converter operates in continuous conduction mode.

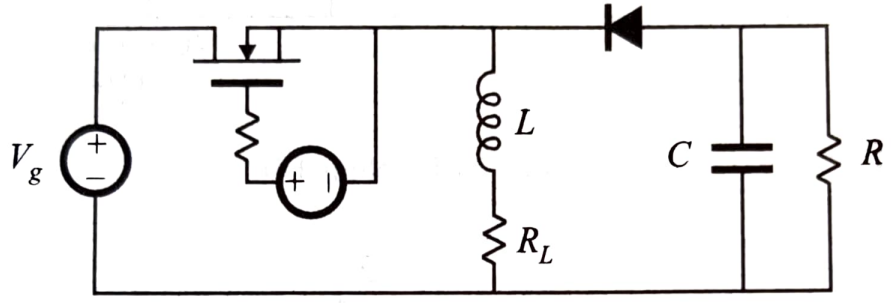

Fig. 4.85 Converter for Problem 4.7

Derive an equivalent circuit that models the dc components of the converter waveforms and that accounts for the loss mechanisms described above.

4.8 Solve the equivalent circuit model derived in Problem 4.7, to find closed-form expressions for the output voltage and inductor current.

4.9 A certain boost converter is implemented with a MOSFET and a p–n diode. The MOSFET can be modeled as ideal, but the diode exhibits a substantial reverse-recovery process, with reverse recovery time t_r and recovered charge Q_r. In addition, the inductor has winding resistance R_L.

(**a**) Derive an equivalent circuit that models the dc components of the converter waveforms and that accounts for the loss elements described above.

(**b**) Solve your model to find an expression for the output voltage.

(**c**) Plot the output voltage vs. duty cycle over the range $0 \leq D < 1$, for the following values: $R_L = 0.25\,\Omega$, $f_s = 150\,\text{kHz}$, $Q_r = 5\,\mu\text{coul}$, $t_r = 100\,\text{nsec}$, $R = 60\,\Omega$, $V_g = 24\,\text{V}$.