

An IGBT and a silicon diode operate in a buck-boost converter. The converter operates with an input voltage  $V_g$ , output voltage  $V$ , and load current  $I_{out}$ . The diode has forward voltage drop  $V_D$  and the IGBT has forward voltage drop  $V_{CE}$ . All other conduction losses can be neglected. The diode exhibits significant reverse recovery loss, with charge  $Q_r$  and time  $t_r$ . Derive and sketch an equivalent circuit which models the DC properties of the buck-boost converter with the specified losses.

