Problem 1.1 (50 points)
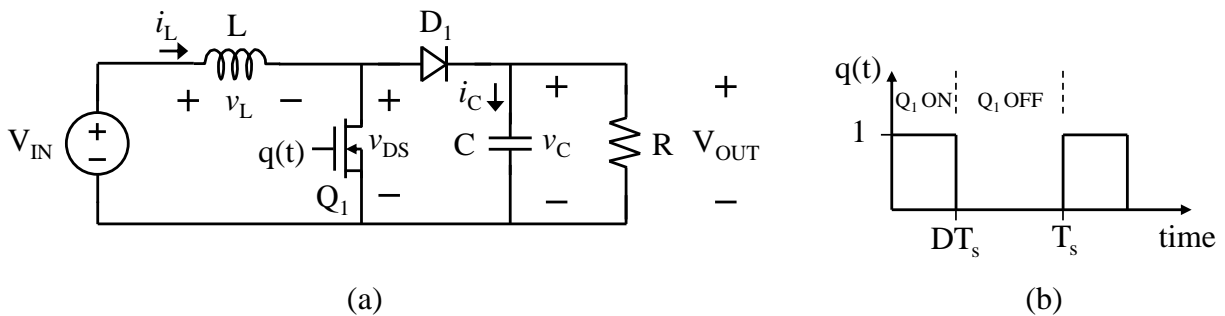
Consider the boost converter shown in Fig. 1.1(a), with its MOSFET, Q_1, controlled by the switching function q(t) shown in Fig. 1.1(b).

(a)   (b)

Figure 1.1

The converter operates under the following conditions:
- Input voltage, $V_{IN} = 5$ V
- Output voltage, $V_{OUT} = 20$ V
- Switching frequency, $f_s = 1$ MHz

Assume that all elements of the converter are ideal, and that it operates in periodic steady state with waveforms similar to those illustrated in Fig. 2.15 of the textbook (pg. 23).

a) What is the duty ratio (also called duty cycle), D, of the converter?
b) Sketch the waveform of the MOSFET drain-to-source voltage, v_{DS}. Label the numerical values of all relevant times and voltages.
c) Find the dc component of the voltage waveform of part (b). How does this value relate to the value of V_{IN}. Does this make sense and why?

Problem 1.2 (50 points)

Do Textbook (Fundamentals of Power Electronics 2nd Edition) Problem 2.1 (pg. 35).

Problem 1.3 (50 points) [Additional problem only for ECEN 5797 students]

Do Textbook (Fundamentals of Power Electronics 2nd Edition) Problem 2.9 parts (a) and (b) only (pg. 37).