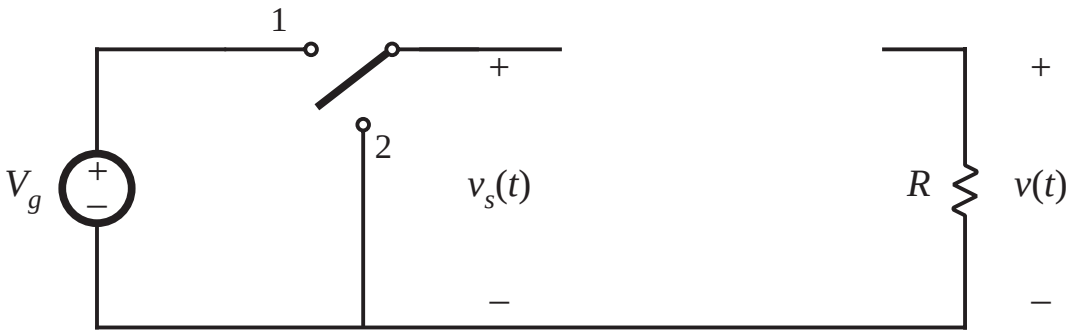
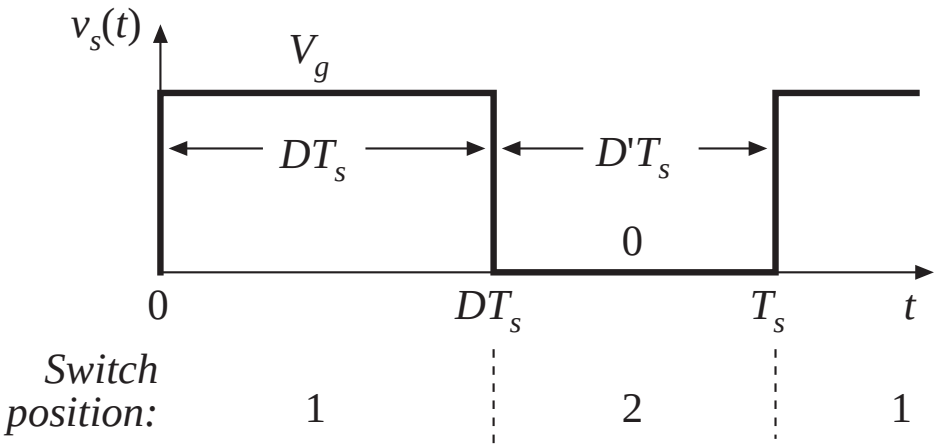
2.1 Introduction
Buck converter

SPDT switch changes dc component



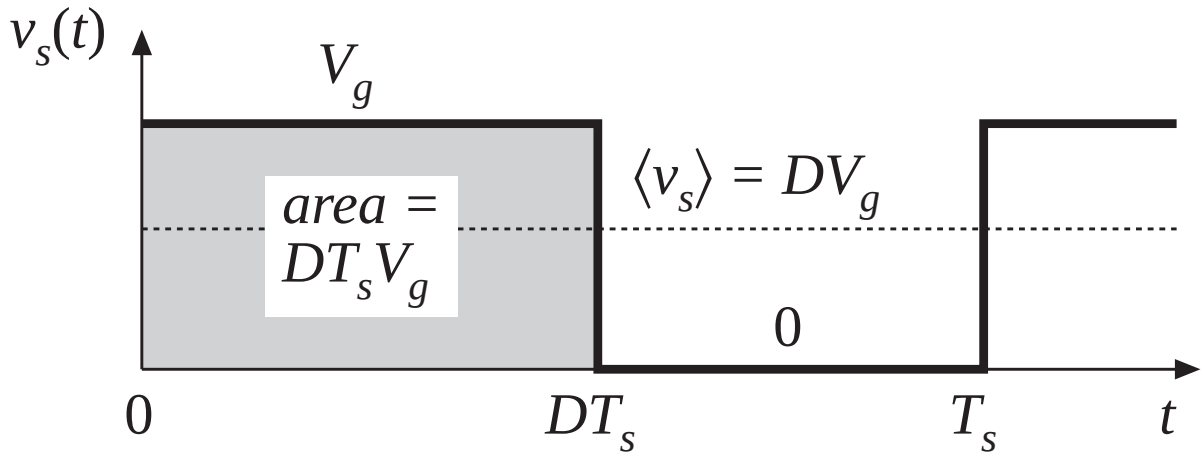
Switch output voltage waveform



Duty cycle *D:*
$0 \le D \le 1$

complement D′:
$D' = 1 - D$

Dc component of switch output voltage

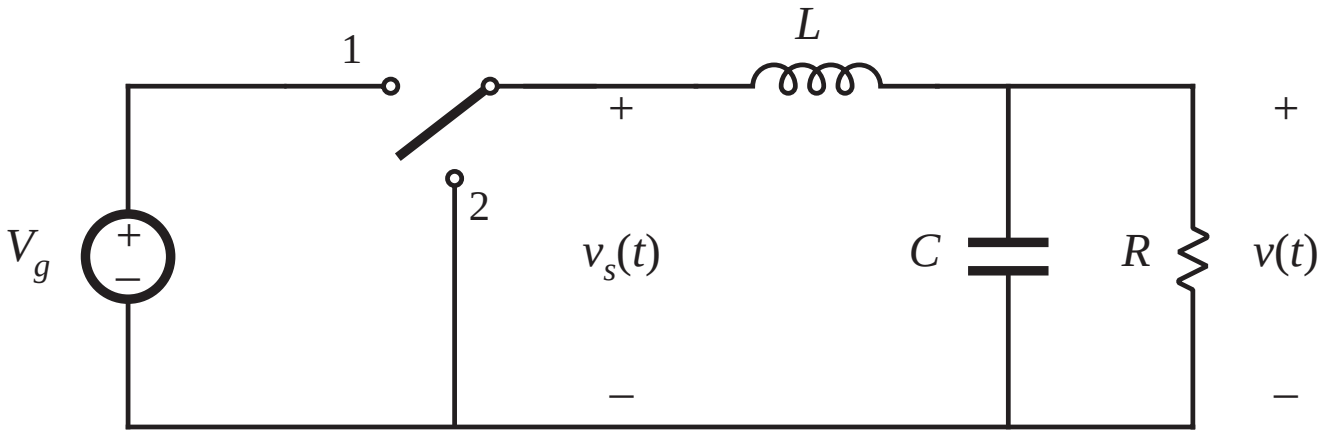


Fourier analysis: Dc component = average value

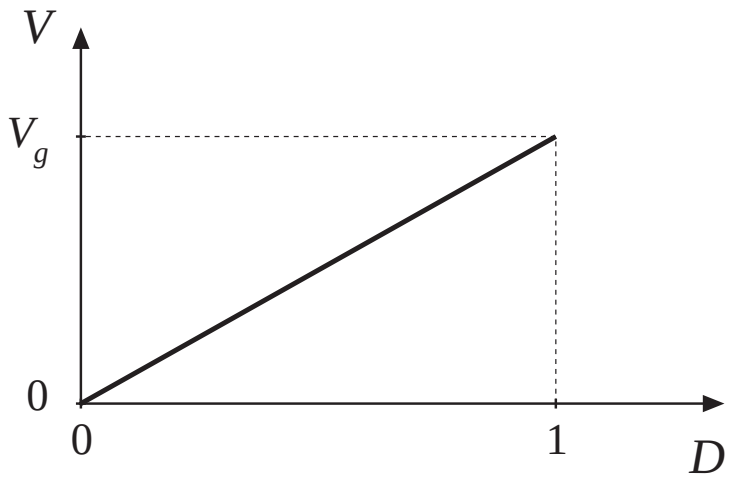
$$\langle v_s \rangle = \frac{1}{T_s} \int_0^{T_s} v_s(t)\, dt$$

$$\langle v_s \rangle = \frac{1}{T_s} (DT_sV_g) = DV_g$$

Insertion of low-pass filter to remove switching harmonics and pass only dc component

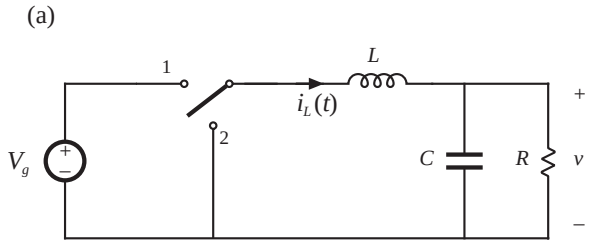


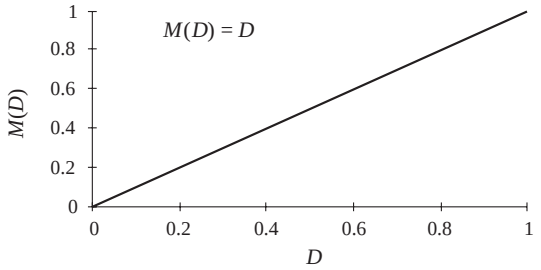
$$v \approx \langle v_s \rangle = DV_g$$



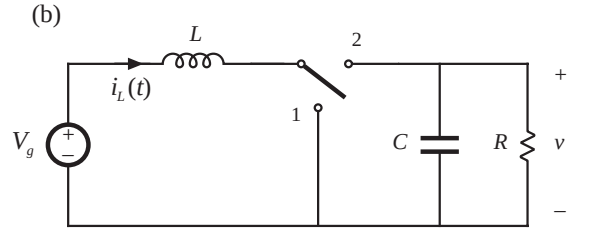
Three basic dc-dc converters

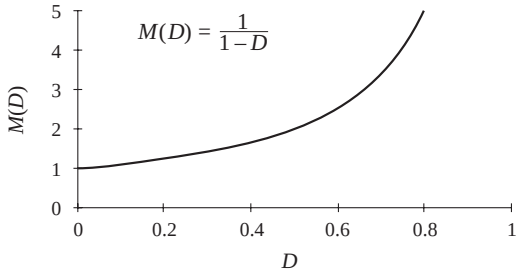
Buck



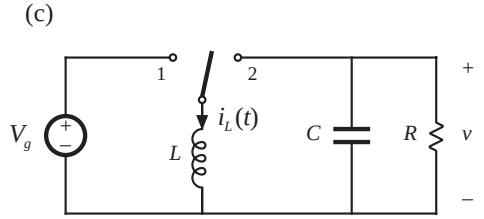


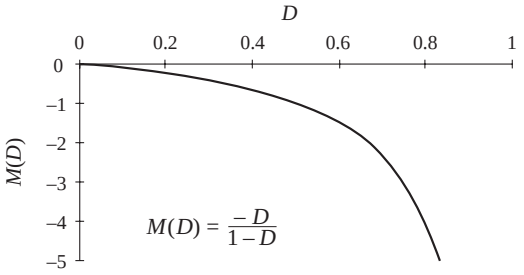
Boost





Buck-boost





Objectives of this chapter

- Develop techniques for easily determining output voltage of an arbitrary converter circuit
- Derive the principles of *inductor volt-second balance* and *capacitor charge (amp-second) balance*
- Introduce the key *small ripple approximation*
- Develop simple methods for selecting filter element values
- Illustrate via examples