Relating Duty Ratio to Modulation Ratio

- The duty ratio, **d**, describes the behavior over **one switching period** at the switching frequency
  - » If the converter is switching a 5 kHz, this would be a period of 0.2 ms,
  - » The duty ratio, **d** can vary between 0 and 1.
- The instantaneous modulation ratio, **m**, can vary between -1 and +1
  - » Allowing it to describe a sinusoidal function
  - » Also defined over one switching period
- Based on these definitions
  - » m=(2d-1) → due to this difference in allowable range of variation.
- But instantaneous values of "m" or "d" don't describe behavior over a full cycle at 60 Hz (or appropriate power frequency).
- Assume the switching frequency is sufficiently high compared to the fundamental frequency such that "d" or "m" is essentially constant over each switching period.

Going from Instantaneous "m" to a Modulation Function

- To describe the variation of m(t) over a full 60 Hz cycle if, we can combine a sequence of "m" terms such that:

$$m(t) = M \cdot \cos(2\pi f \cdot t + \delta)$$

- We refer to this as modulating function.
- We can relate the low frequency (near power frequency) behavior of the ac voltage at the converter terminals to the dc voltage through m(t) using equation (2.26), where the bar over the V_t means low

$$\overline{v_{at}(t)} = m(t) \cdot \frac{V_{dc}}{2} = M \cdot \cos(2\pi f \cdot t + \delta) \cdot \frac{V_{dc}}{2}$$

- For the normal power system steady-state, fundamental frequency term is:

$$\overline{v_{at}(t)} = V_m \cdot \cos(2\pi f \cdot t + \delta)$$

- The **peak amplitude** of the sinusoid can be related to dc voltage by

$$V_m = M \cdot \frac{V_{dc}}{2}$$