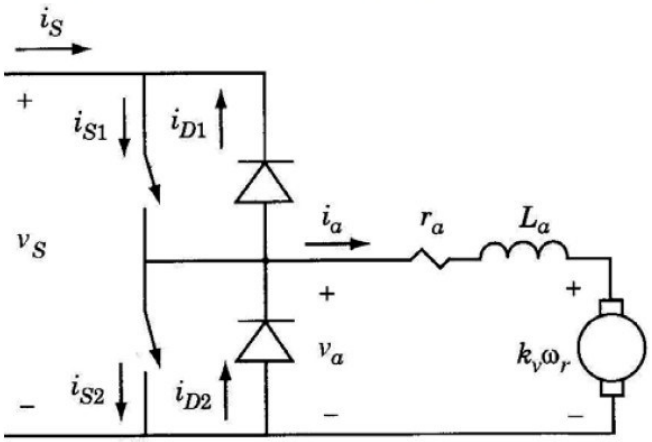
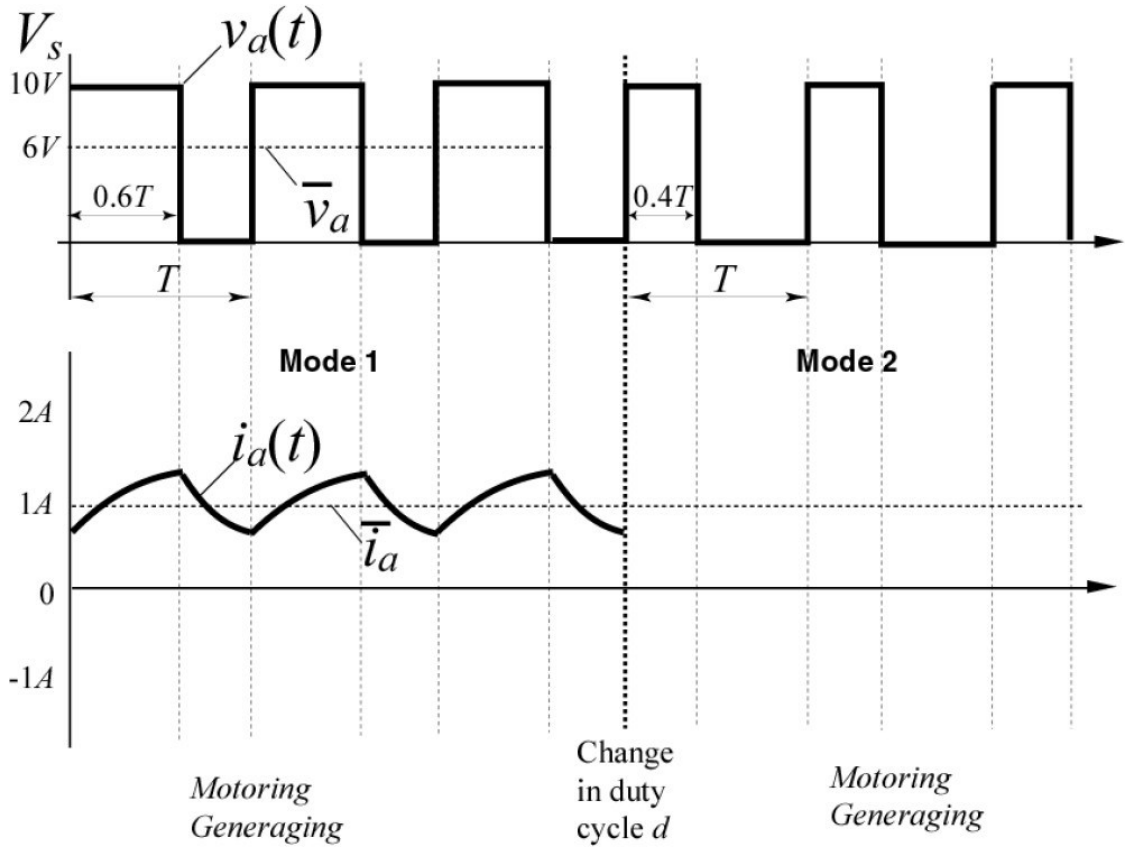
Assume a PM DC motor is driven by a PWM converter shown below. The motor shaft is connected to a constant speed mechanical system (load) with $\omega_r = 10\,r/s$. The motor parameters are $k_v = 0.5\,Vs/r$ and $r_a = 1\Omega$. The converter is supplied form a 10 V dc source. Initially, in **Mode 1**, the duty cycle $d = 0.6$ (60% on and 40% off). The corresponding voltage and current waveforms are depicted on the figure below (first interval), wherein the average values of the voltage $\bar{v}_a = 6V$ and current $\bar{i}_a = 1A$ are also shown. Assume that the duty cycle has changed to 0.4 (40% on and 60 off), as shown on the figure. This is a new steady-state operation in **Mode 2**:



(a) (5pts): Determine whether machine is **Motoring** or **Generating** in each **Mode?** and circle appropriate

(b) (5pts): Find the value of the average voltage $\bar{v}_a$ for the **Mode 2** and show it on the figure

(c) (5pts): Sketch the steady-state waveform of the current $\bar{i}_a$ in Mode 2 and find/show its average value



A dc shunt machine (10 kW, 250 V, 1200 rpm) has $R_a = 0.25\ \Omega$. The machine is connected to a 250 V dc supply, draws rated armature current, and rotates at 1200 rpm.

(a) Determine the generated voltage, the electromagnetic power developed, and the torque developed.

(b) The mechanical load on the motor shaft is thrown off, and the motor draws 4 A armature current.

(i) Determine the rotational loss.

(ii) Determine speed

P 4.38):

A dc motor is mechanically connected to a constant-torque load. When the armature is connected to a 120 V dc supply, it draws an armature current of value 8 A and runs at 1800 rpm. The armature resistance is $R_a = 0.08\ \Omega$. Accidentally, the field circuit breaks and the flux drops to the residual flux, which is only 5% of the original flux.

(a) Determine the value of the armature current immediately after the field circuit breaks (i.e., before the speed has had time to change from 1800 rpm).

(b) Determine the theoretical final speed of the motor after the field circuit breaks.