Switched Mode Power Supply

- $v_I$ – periodically applied across an inductance for short time intervals
- energy is stored in the magnetic field $(1/2)Li_L^2$
- the energy is then transferred on a filtering capacitor, to the output
- the capacitor act like an energy reservoir and provides current into the load between the charging intervals
- the capacitor also smoothes the output voltage
**Step-down Converter or Buck Converter**

\[ V_I \quad v_{CO} \quad D \quad v_F \quad v_L \quad i_{c} \quad I_O \quad R_L \quad V_O \]

\[ i_I \quad K \quad F \quad i_L \quad L \]

\( K \) is an ideal switch, \( p \) type (MOST \( p \) channel; BJT \( pnp \) );
All elements are lossless (except for load resistance);
The circuit operates in the steady state regime (all waveforms are periodic);
Output voltage is constant, (the ripple of the output voltage is neglected against the average value of \( V_O \));
The input voltage is constant
Step-down Converter or Buck Converter – cont.

\[ \frac{T_c}{T_c + T_b} = \delta \]

Duty factor

\( T_c \) - conduction interval of \( K \) - energy is stored in the magnetic field of \( L \)

\( T_b \) - blocking interval of \( K \) – energy is released to the output
\[
\Delta t = T_c \\
\Delta i_L = I_{L_{\text{max}}} - I_{L_{\text{min}}} = \frac{1}{L} (V_I - V_O)T_c \\
\Delta t = T_b \\
- \Delta i_L = I_{L_{\text{min}}} - I_{L_{\text{max}}} = \frac{1}{L} (-V_O)(T_b) = -\frac{1}{L} V_O T_b \\
\frac{1}{L} (V_I - V_O)T_c = \frac{1}{L} V_O T_b \\
V_O = \frac{T_c}{T_c + T_b} V_I \\
\frac{T_c}{T_c + T_b} = \frac{T_c}{T} = \delta \\
V_O = \delta V_I
\]
Step-up Convertor or Boost Convertor

\[ V_O = \frac{1}{1-\delta} V_I \]

\[ \delta < 1 \quad V_O > V_I \]
Step-down/Step-up Converter or Buck-Boost Converter

\[ V_o = -\frac{\delta}{1-\delta} V_I \]

- \( \delta > 0.5 \) The magnitude of the output voltage is greater than the input voltage
- \( \delta < 0.5 \) The magnitude of the output voltage is less than the input voltage