DC – DC Power Conversion

Switched mode power supplies / Choppers.

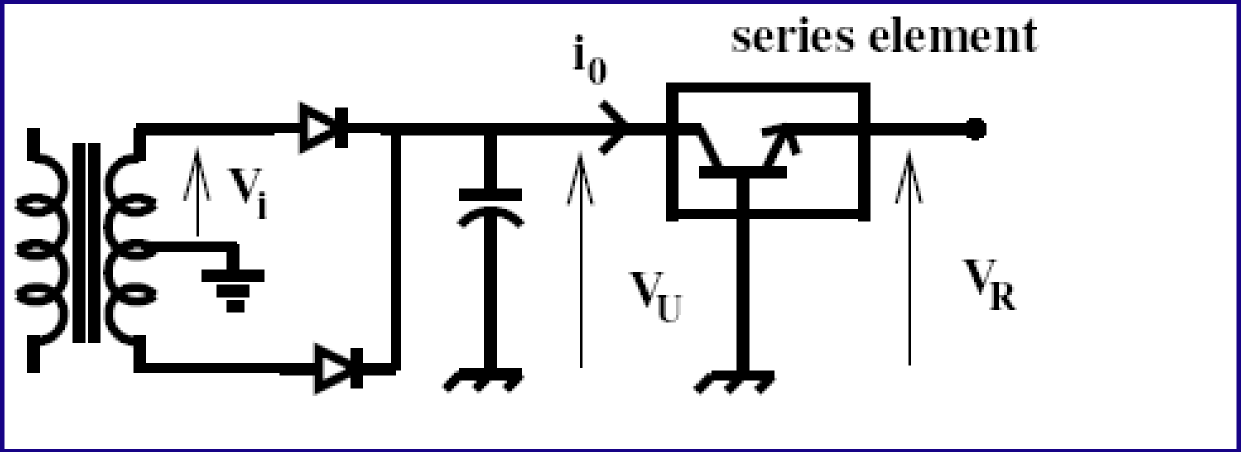
$\rightarrow$ High power $\rightarrow$ D.C. motor speed control

Calcutta metro : 750V DC

Bombay – Igatpuri : 1500V

Power supplies : In computers, any electronic equipments.

Consider Linear regulated power supply

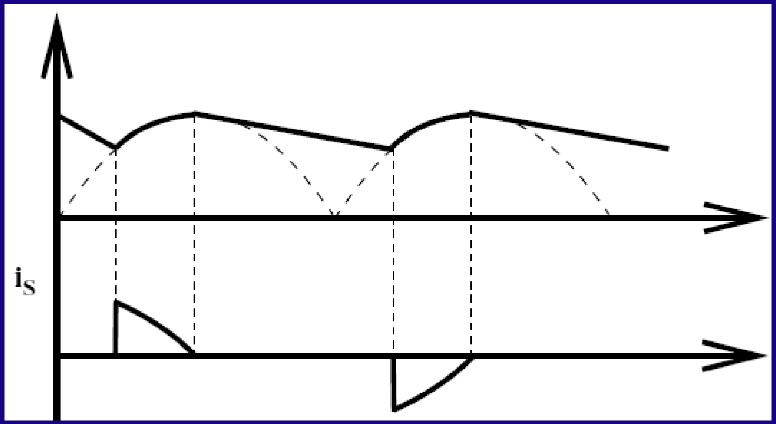


Cathode pot. of diode $= V_u$

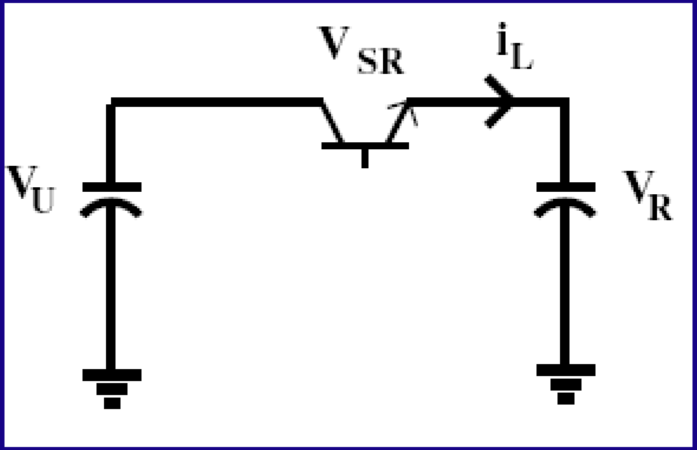
$\therefore$ 'D' is off $V_{anode} < V_u$

When 'D' is ON, $V_i = V_u$

$$i_s = C\frac{dV_u}{dt} + i_0$$



In order to get regulated power supply, use series regulator.



$$V_{SR} = V_U - V_R$$

As $V_U \uparrow,\ V_{SR} \uparrow$

$\Rightarrow$ 7805 Regulator

$V_{U(min)} = 7.5V$ || $V_R = 5V$

$V_{U(max)} = 35V$

Power loss in the device $= V_{SR} * i_L$

Disadvantages :

- η is low.
- 50Hz Transformer.
- Heat sink requirement $\uparrow$
- Large size of C
- Source I is peaky, Harmonic content is high.

Bulky

S.M.P.S. : $-$Frequency of operation is high $\approx$ 100KHz

$\Rightarrow$ Magnetics are operated at this frequency.

$\Rightarrow$ Broadly classified into 2 groups.

a) Without Transformer
b) With Transformer

Operation is not at 50Hz

$VA = (4.44 F \phi N) * I$

As $F \uparrow$, $N \downarrow$, core loss $\uparrow$

$\Rightarrow$ Use ferrite core $-$ Brittle, B_{av} is around 0.2 - 0.25 T

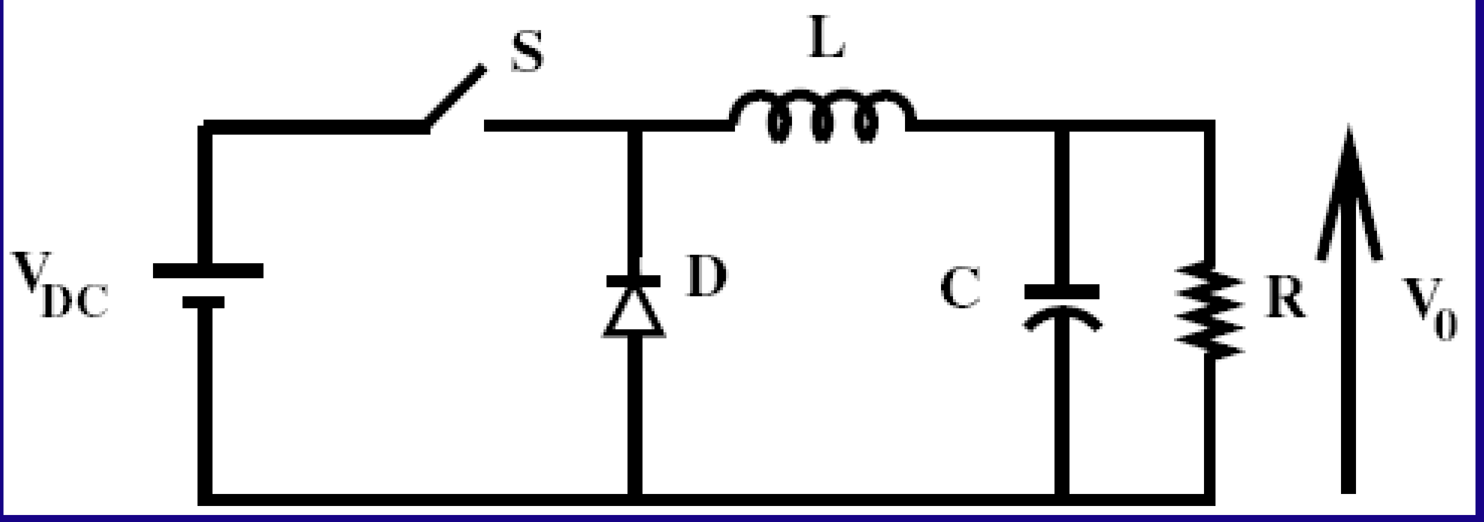
$\Rightarrow$ Amorphous Alloy - B_{av} is of the order 1 - 1.1 T

Buck converter :

$L_F \rightarrow$ Filter inductor.

$C_F \rightarrow$ Filter capacitor.

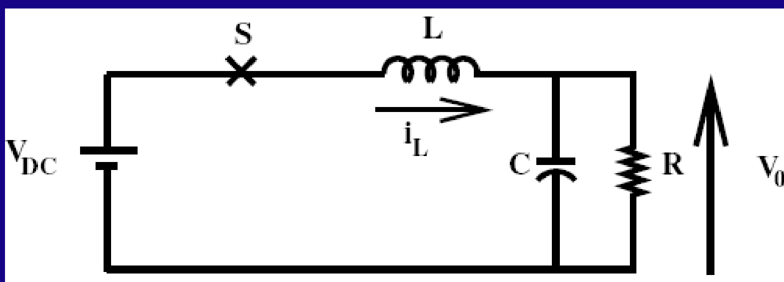
$'V_0'$ is assumed to remain constant.

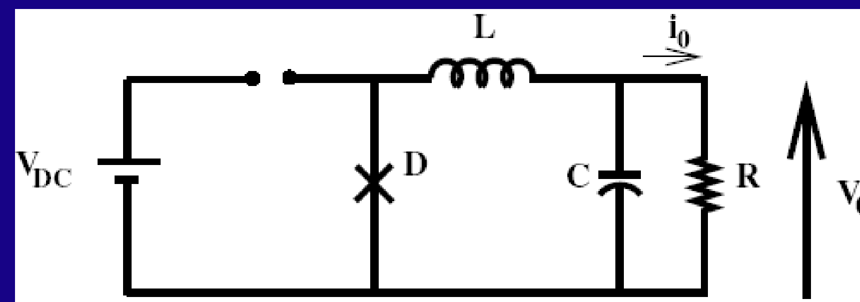


'S' is switched at a very high frequency.

S – ON for DT

– OFF for $(1-D)T$





$$V_L = V_{DC} - V_0 \quad 0 < t < DT$$

$$= \text{Constant}$$

$i_L \uparrow$ Linearly

$$i_L = C\frac{dV_0}{dt} + \frac{V_0}{R}$$

$$V_D = -V_{DC}$$

$$V_L = -V_0 \qquad (1-D)T < t < T$$

$i_L \downarrow$ Linearly

$$i_L = C\frac{dV_0}{dt} + \frac{V_0}{R}$$

$$V_S = V_{DC}$$

$$\text{Av. 'V' across L} = 0$$

$$\left(V_{DC} - V_0\right)DT = \left(V_0\right)\left(1 - D\right)T$$

$$V_0 = DV_{DC}$$

$$\left(i_L\right)_{av} = C\left(\frac{dV_0}{dt}\right)_{av} + \frac{\left(V_0\right)_{av}}{R}$$

$$\text{'}V_0\text{' is assumed to be constant}$$

$$\left(\text{variation over the cycle} = 0\right)$$

$$\text{At steady state } V_0\big|_{t=0} = V_0\big|_T$$

$$\therefore \left.\frac{dV_0}{dt}\right|_{av} = \underline{\underline{0}} \qquad \therefore \frac{V_0}{R} = I_L$$