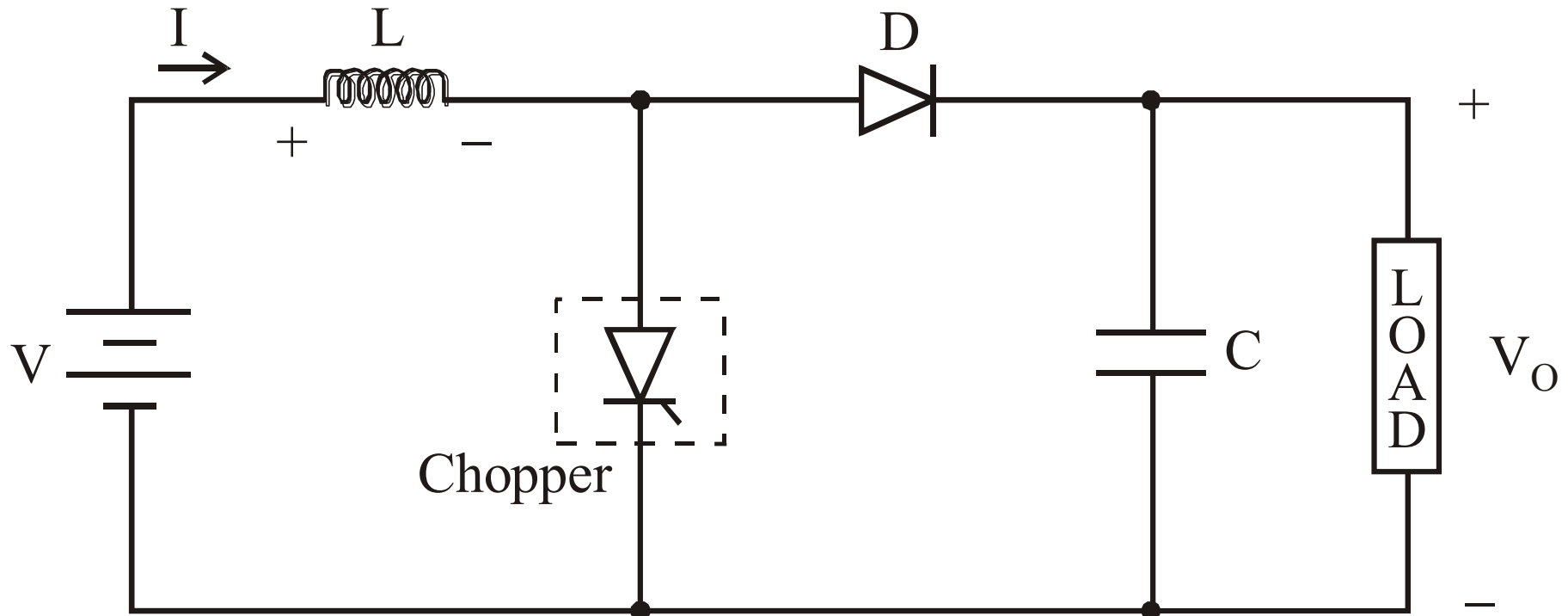


# Principle Of Step-up Chopper



- Step-up chopper is used to obtain a load voltage higher than the input voltage  $V$ .
- The values of  $L$  and  $C$  are chosen depending upon the requirement of output voltage and current.
- When the chopper is *ON*, the inductor  $L$  is connected across the supply.
- The inductor current ' $I$ ' rises and the inductor stores energy during the *ON* time of the chopper,  $t_{ON}$ .



- When the chopper is off, the inductor current  $I$  is forced to flow through the diode  $D$  and load for a period,  $t_{OFF}$ .
- The current tends to decrease resulting in reversing the polarity of induced EMF in  $L$ .
- Therefore voltage across load is given by

$$V_o = V + L \frac{dI}{dt} \quad i.e., \quad V_o > V$$



- A large capacitor 'C' connected across the load, will provide a continuous output voltage .
- Diode  $D$  prevents any current flow from capacitor to the source.
- Step up choppers are used for regenerative braking of dc motors.



# Expression For Output Voltage

Assume the average inductor current to be  $I$  during ON and OFF time of Chopper.

**When Chopper is ON**

Voltage across inductor  $L = V$

Therefore energy stored in inductor

$$= V \cdot I \cdot t_{ON}$$

Where  $t_{ON}$  = ON period of chopper.



## When Chopper is OFF

(energy is supplied by inductor to load)

Voltage across  $L = V_o - V$

Energy supplied by inductor  $L = (V_o - V) I t_{OFF}$

where  $t_{OFF} = OFF$  period of Chopper.

Neglecting losses, energy stored in inductor

$L =$  energy supplied by inductor  $L$



$$\therefore VIt_{ON} = (V_o - V) It_{OFF}$$

$$V_o = \frac{V [t_{ON} + t_{OFF}]}{t_{OFF}}$$

$$V_o = V \left( \frac{T}{T - t_{ON}} \right)$$

Where

T = Chopping period or period  
of switching.



$$T = t_{ON} + t_{OFF}$$

$$V_o = V \left( \frac{1}{1 - \frac{t_{ON}}{T}} \right)$$

$$\therefore V_o = V \left( \frac{1}{1 - d} \right)$$

Where  $d = \frac{t_{ON}}{T} = \text{duty cycle}$





For variation of duty cycle ' $d$ ' in the range of  $0 < d < 1$  the output voltage  $V_o$  will vary in the range  $V < V_o < \infty$



# Performance Parameters

- The thyristor requires a certain minimum time to turn *ON* and turn *OFF*.
- Duty cycle  $d$  can be varied only between a min. & max. value, limiting the min. and max. value of the output voltage.
- Ripple in the load current depends inversely on the chopping frequency,  $f$ .
- To reduce the load ripple current, frequency should be as high as possible.



# Problem

- *A Chopper circuit is operating on TRC at a frequency of 2 kHz on a 460 V supply. If the load voltage is 350 volts, calculate the conduction period of the thyristor in each cycle.*



$$V = 460 \text{ V}, V_{dc} = 350 \text{ V}, f = 2 \text{ kHz}$$

Chopping period

$$T = \frac{1}{f}$$

$$T = \frac{1}{2 \times 10^{-3}} = 0.5 \text{ msec}$$

Output voltage

$$V_{dc} = \left( \frac{t_{ON}}{T} \right) V$$



# Conduction period of thyristor

$$t_{ON} = \frac{T \times V_{dc}}{V}$$

$$t_{ON} = \frac{0.5 \times 10^{-3} \times 350}{460}$$

$$t_{ON} = 0.38 \text{ msec}$$

