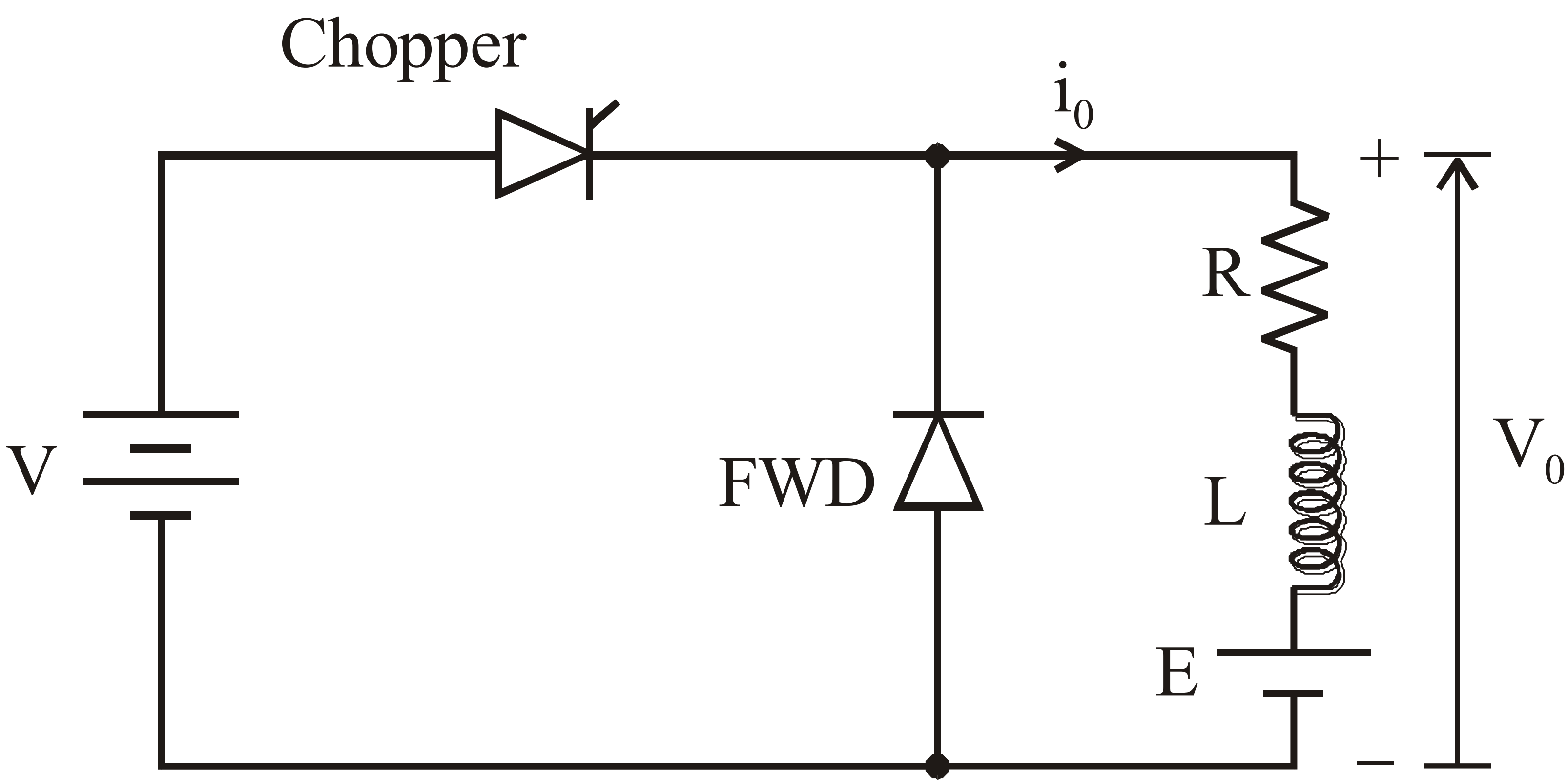
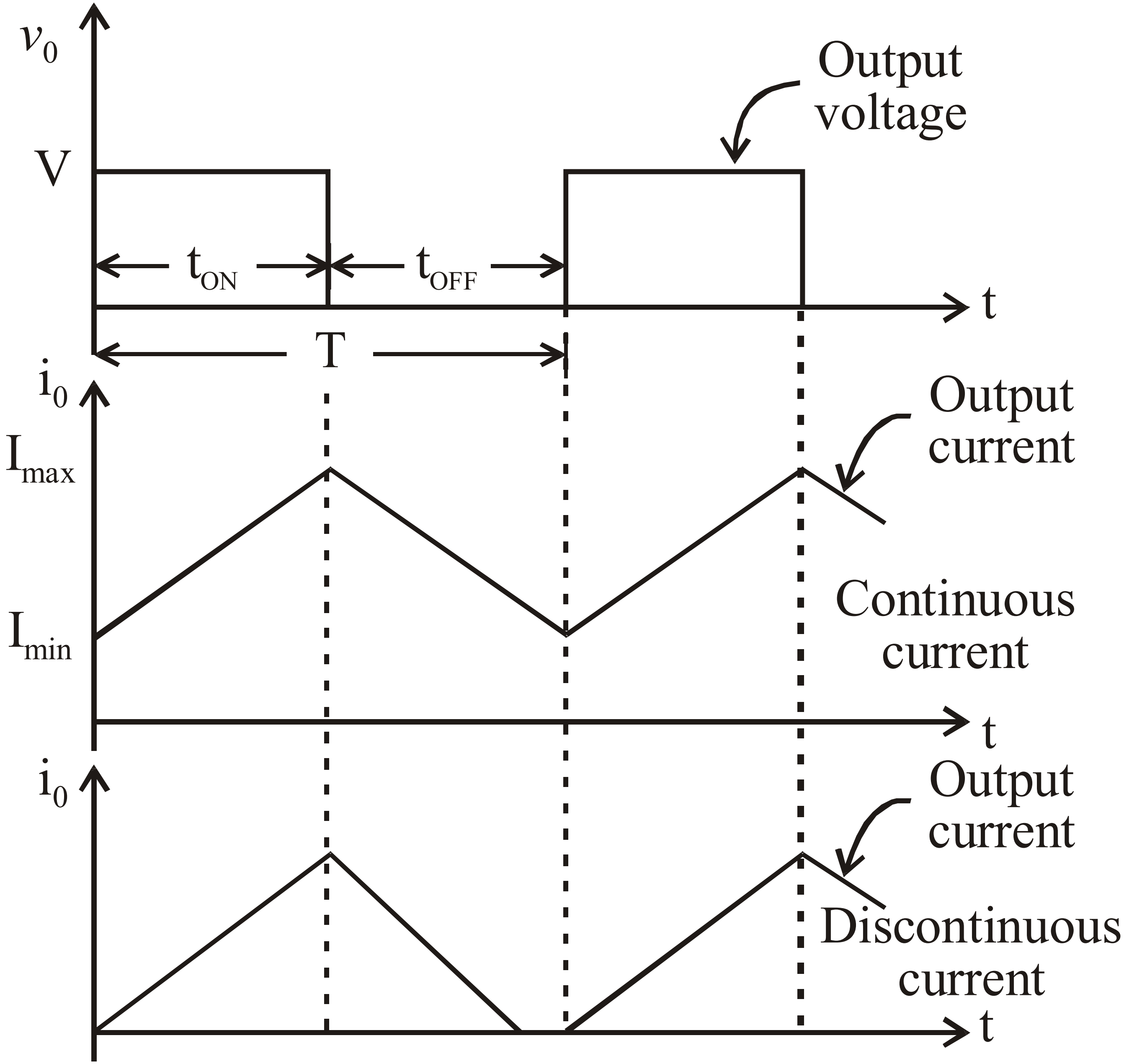
Methods Of Control

- The output dc voltage can be varied by the following methods.
  - Pulse width modulation control or constant frequency operation.
  - Variable frequency control.

Step-down Chopper
With R-L Load

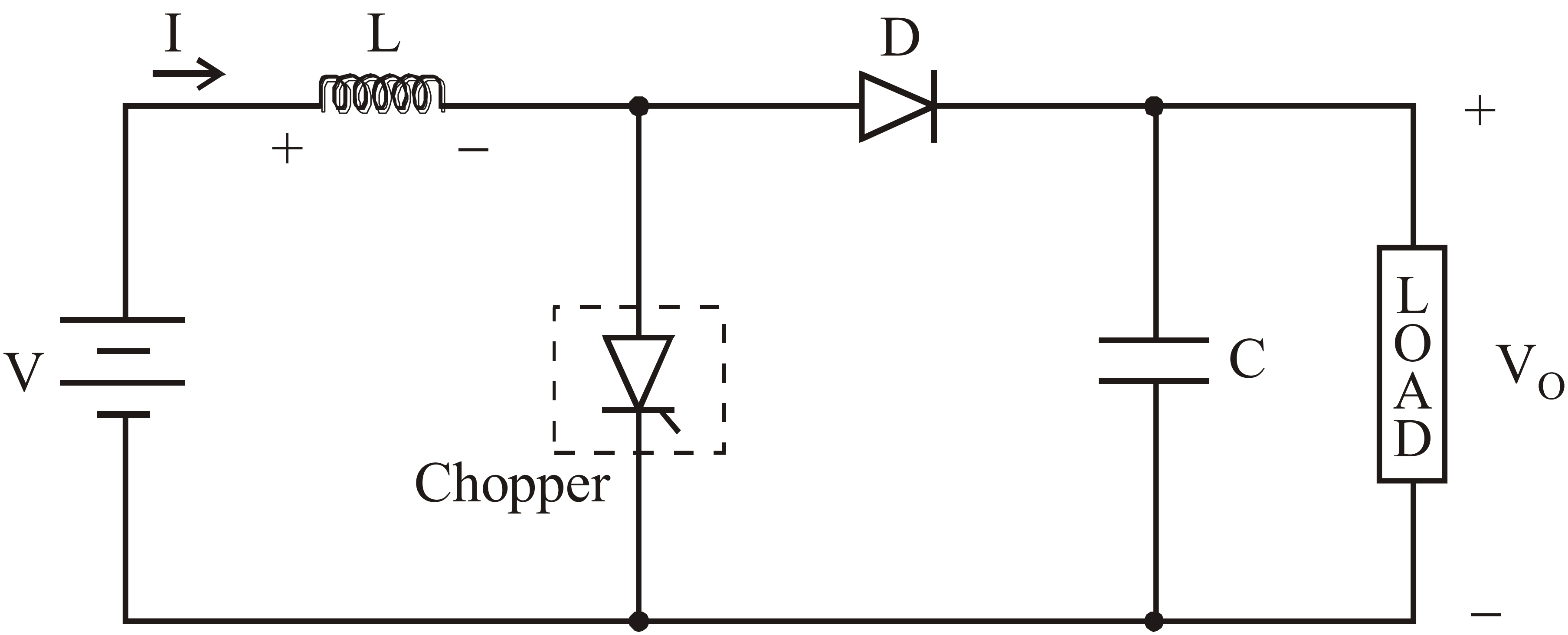


- When chopper is ON, supply is connected across load.
- Current flows from supply to load.
- When chopper is OFF, load current continues to flow in the same direction through FWD due to energy stored in inductor *'L'*.



v_0
Output voltage
V
t_{ON}
t_{OFF}
t
T
i_0
I_{max}
Output current
I_{min}
Continuous current
t
i_0
Output current
Discontinuous current
t

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

$$= V.I.t_{ON}$$

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 $L = \left(V_O - V\right) It_{OFF}$

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

Neglecting losses, energy stored in inductor

$L =$ energy supplied by inductor L

$$\therefore \quad VIt_{ON} = \left(V_O - V\right) It_{OFF}$$

$$V_O = \frac{V\left[t_{ON} + t_{OFF}\right]}{t_{OFF}}$$

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

Where

T = Chopping period or period of switching.

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

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

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

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