INDUSTRIAL ELECTRONICS ASSIGNMENT

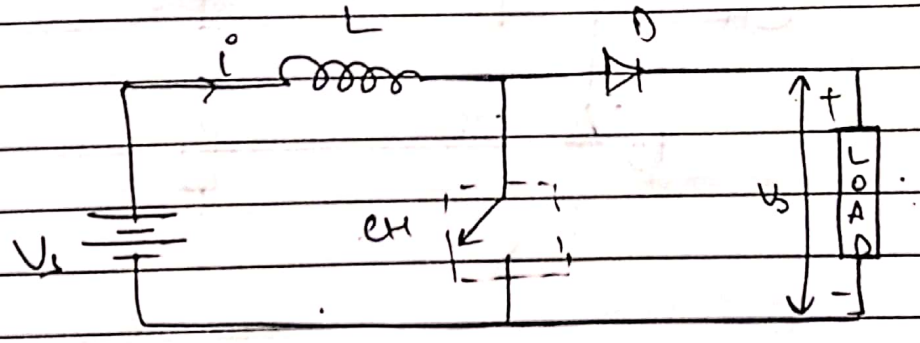
PAGE NO.
DATE

Ques-1 With the help of circuit diagram explain, the working of step up / step down chopper.

Ans The chopper is a high speed On/Off switch in both the choppers, switch connects with the load and disconnects at very fast speed or rate. Hence chopped output is derived from constant dc supply voltage.

(1) Step-up chopper

It is also called Boost converter, as it increases the input voltage.



working

- When the chopper is (on) state, the switch here is closed & current flows. Hence inductor connected in series stores energy during this ON period.

- When the chopper is Off state, the switch here is open inductor current does not reduce instantaneously & it flows through the diode & load during this off period.

- Due to above, voltage across to load exceeds the source voltage V_s. Hence the circuit is referred as step-up chopper.

- Eq^n for average load voltage :-

$$V_o = \left(\frac{T}{T_{off}}\right) V_s$$

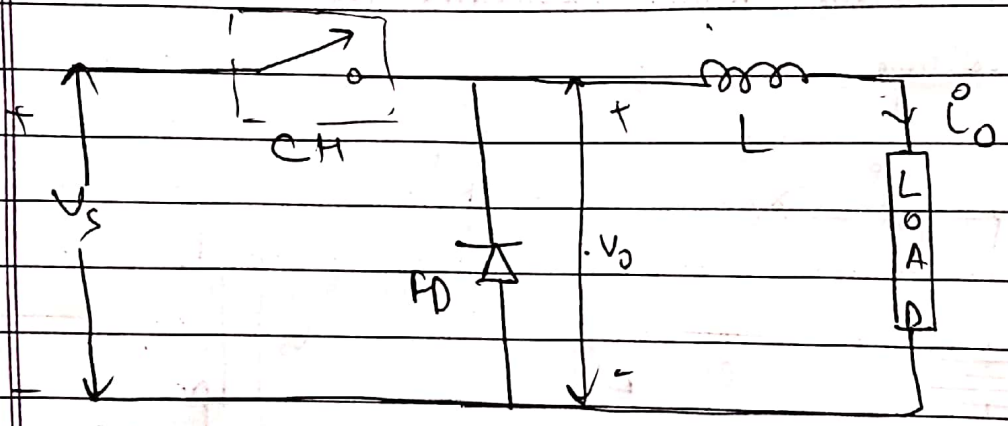
$$= \left(\frac{1}{1-\alpha}\right) V_s$$

α : Duty cycle

$T = T_{on} + T_{off}$

(2) Step-Down Chopper

It is also known as buck converter, as it decreases the input voltage



working

- When the chopper is in ON state, load voltage is equal to source voltage

- When the chopper is OFF state, the load current flows through the diode. As a result, load terminals are short circuit by the diode. Hence load voltage is 0 during the off period.

- Due to above, load current increases during ON period and decreases during OFF period. Hence chopped DC voltage is available at the load. Hence the circuit is referred as Step down chopper

- eqn of average load voltage

$$V_0 = \left(\frac{T_{ON}}{T_{ON} + T_{off}}\right) V_s = \alpha V_s$$

$T = T_{ON} + T_{off}$

α = duty cycle.

Ques 2 Differentiate b/w constant frequency control & variable frequency control strategies used for chopper

Ans • Constant frequency control.

- The chopping frequency is kept constant in this method therefore, it is called constant frequency control.

- The chopper ON time or chopper OFF time is adjusted in this method, therefore it is called pulse width modulation control.

- When chopper ON time & OFF time is kept equal, the output voltage is equal to half the input voltage

$$V_0 = \left(\frac{T_{ON}}{T_{ON} + T_{OFF}}\right) V_{dc}$$

$$= \left(\frac{T_{ON}}{T_{ON} + T_{ON}}\right) V_{dc} = 0.5 V_{dc}$$

DATE

- If the chopper ON time is kept 1/4 times chopper OFF time, the output voltage becomes 20% of input voltage

$$V_o = \left(T_{ON} / T_{ON} + T_{OFF}\right) V_{dc}$$

$$= \left(\frac{T_{ON}}{T_{ON} + 4T_{ON}}\right) V_{dc} = 0.2 V_{dc}$$

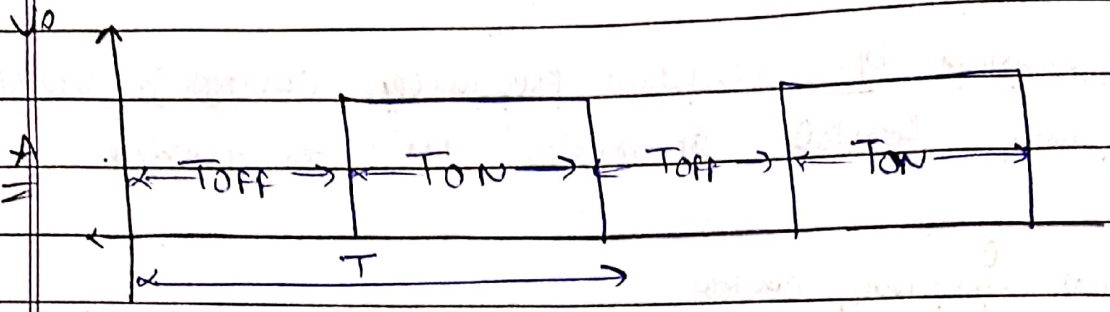
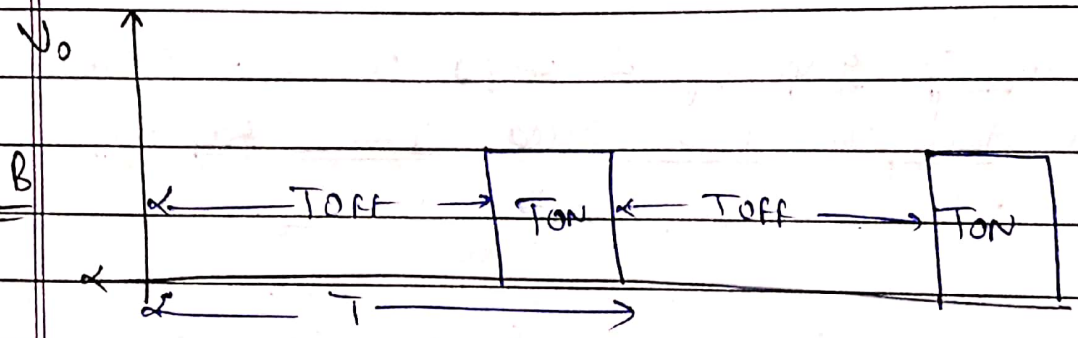


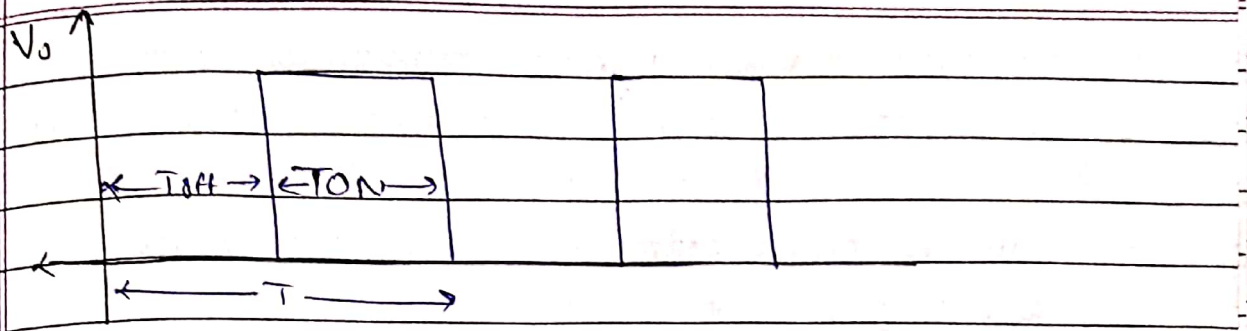
Fig - A

(A) $T_{ON} = T_{OFF}$

(B) $= T_{ON} = 1/4 T_{OFF}$



- Variable frequency control: (Freq modulation technique)
- The chopping frequency is kept variable in this method & chopper ON time or OFF time is kept constant therefore it is called a frequency modulation control.
- The chopper OFF time is kept constant & chopper frequency is kept variable as shown in fig B.
- Similarly the chopper ON time is kept constant & chopper freq is kept variable in fig C.



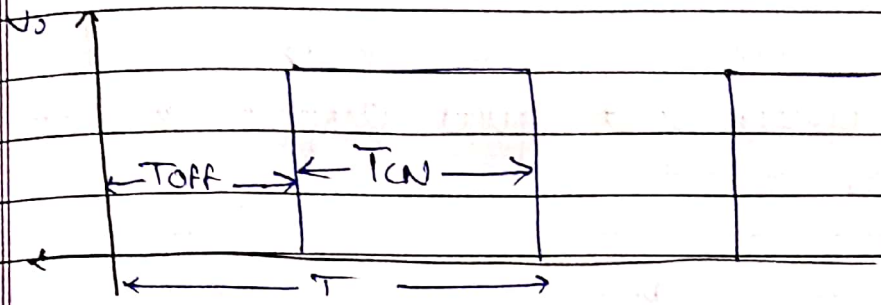
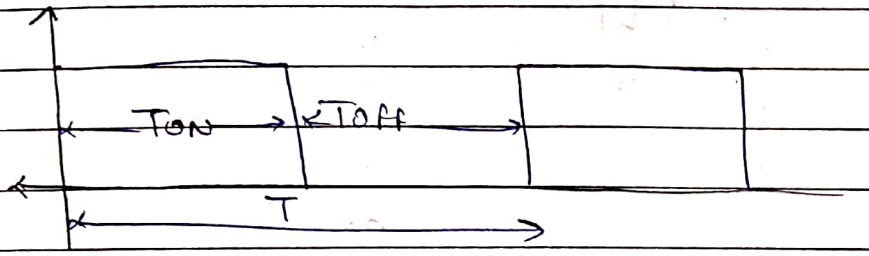


Fig-B
TOFF constant



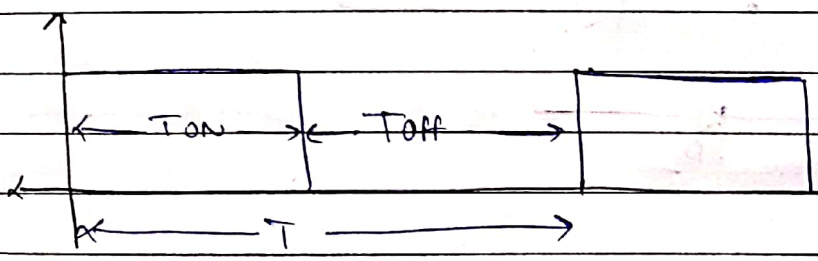


Fig-C
TON constant

Disadvantages of variable freq control over constant freq control

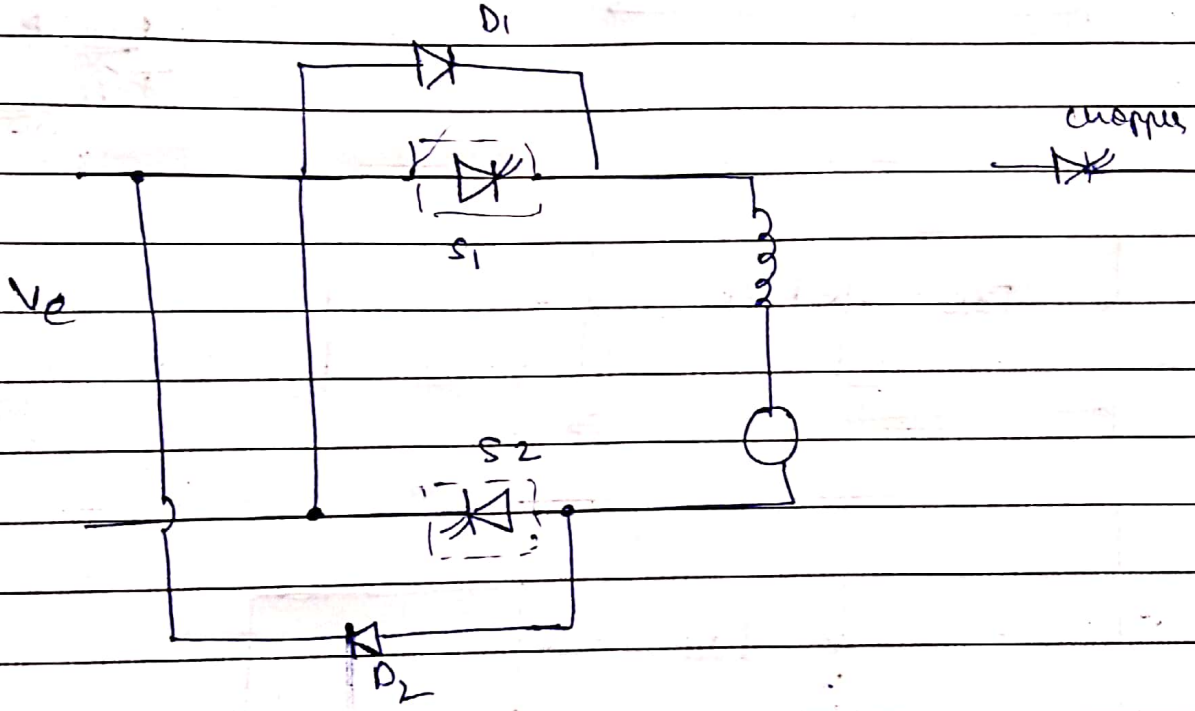
- The design of filter circuit is difficult because the range of chopping frequency is very large in order to control output voltage.

- The load current becomes discontinuous if the chopper is ON time is kept higher than the chopper OFF time

- There is communication interference with nearby telecommunication lines or other digit signal.

Q Draw circuit of a quad chopper & explain its working

Ans



Working

- Sometime a chopper may be required to provide a 2 quadrant operation by the reversing the direction in both motoring & braking mode. Such a chopper is called 2-quadrant chopper as in above fig.

- The chopper results a change in the polarity of terminal voltage keeping the direction of current constant

S_1, S_2 → choppers (electronic switches)
D_1, D_2 → diodes (feedback diodes)
assuming S_1 & S_2 operates simultaneously

- when they are ON, the load current I_a increases, with the rate of rise depending upon the back emf & torque of the machine. When they are OFF, the load current is fed to the supply through the diodes D_1 & D_2 the current decreases in this stage.

- V_a is effectively the when diodes conduct

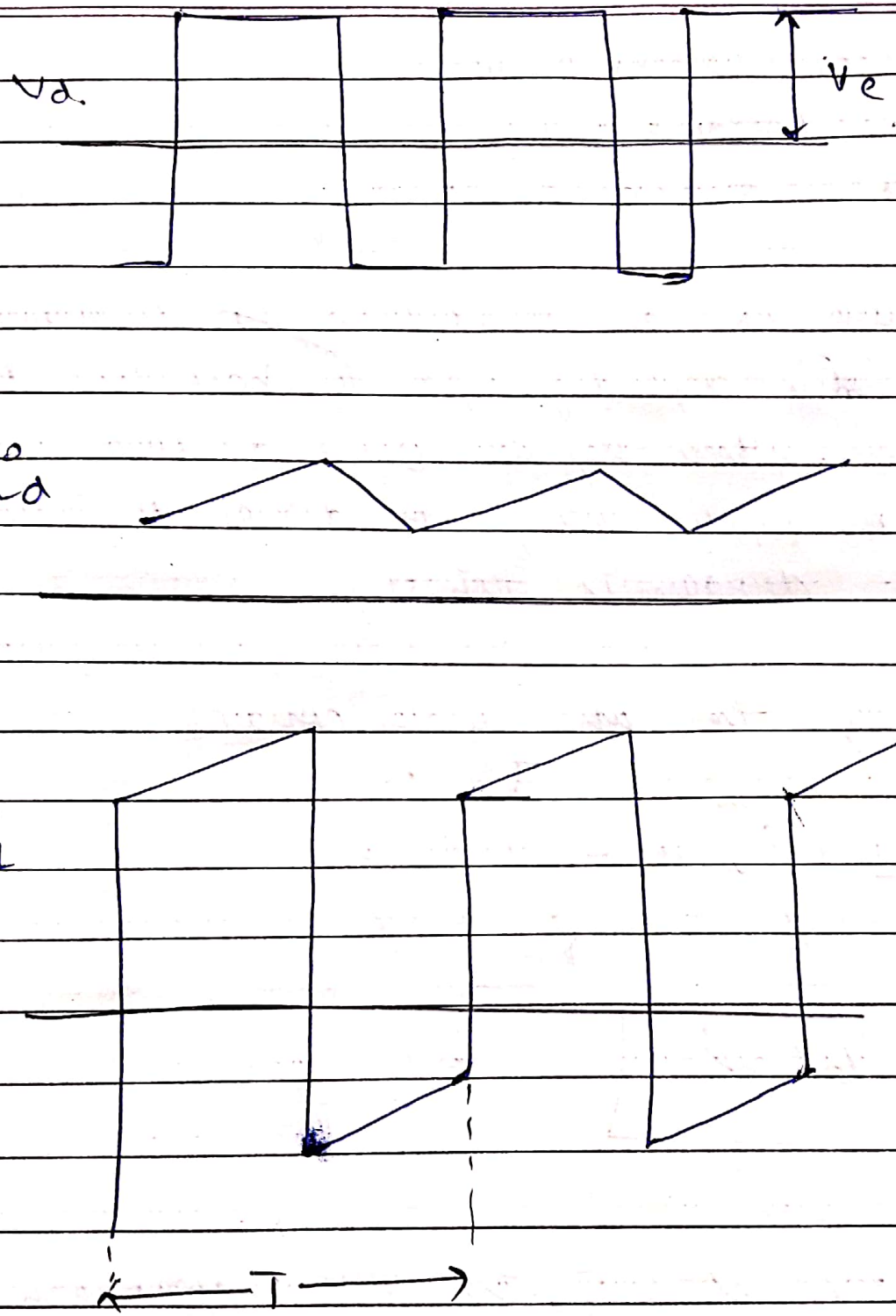
$$V_{avg} = \frac{1}{T}\left(\int_0^{T_{ON}} V_a\,dt - \int_{T_{ON}}^{T} V_d\,dt\right)$$

$$\boxed{V_{avg} = V_d(2\alpha - 1)} \qquad \alpha = \frac{T_{ON}}{T}$$

- $V_{avg} = 0$ for $\alpha = 0.5$, the output voltage is an ac waveform with avg voltage equal to 0.

- for $\alpha > 0.5$, the $V_{avg} = (-ive)$, the chopper works in regeneration mode. The power flows from load to the supply & the dc machine operates as generator.

- $\alpha > 0.5$ the chopper in normal operation. The power flows from supply to the load. This is similar to rectification of the converter ($\alpha < 90°$)



current & voltage waveforms.