Circuit Design of Boost Converter

Aim : *Determine values of L & C for given specifications of a boost converter.*

Specifications :

$$V_s = Supply\ voltage = 5\ V$$

$$V_o = Output\ voltage = 20\ V$$

$$I_o = Output\ current = 2\ A\ (for\ a\ resistive\ load\ of\ 10\ \Omega)$$

$$Permissible\ ripple\ of\ 10\ \%$$

Formulas used :

$$D = Duty\ cycle = \frac{V_o - V_s}{V_o} \tag{1}$$

$$\Delta I_L = Inductor\ current\ ripple = \frac{DV_s}{fL} \tag{2}$$

$$\Delta V_c = \Delta V_o = Capacitor/Output\ voltage\ ripple = \frac{DI_o}{fC} \tag{3}$$

$$I_L = Mean\ inductor\ current = \frac{I_o}{1 - D} \tag{4}$$

Calculations :

We choose the frequency of the circuit as **f = 25000 Hz**.

Using (1),

$$D = \frac{20-5}{20} = 0.75$$

Using (4),

$$I_L = \frac{2}{1-0.75}\ A = 8\ A$$

As the allowed ripple is 10%,

$$\therefore \Delta I_L = \frac{10}{100} \cdot 8\ A = 0.8\ A$$

$$\therefore \Delta V_o = \frac{10}{100} \cdot 20\ V = 2\ V$$

Using (2),

$$L = \frac{DV_s}{f\Delta I_L} = \frac{0.75 \times 5}{25000 \times 0.8}\ H = 1.875 \times 10^{-4}\ H$$

Using (3),

$$C = \frac{DI_o}{f\Delta V_o} = \frac{0.75 \times 2}{25000 \times 2}\ F = 3 \times 10^{-5}\ F$$

Results :

a) *For* V_o,

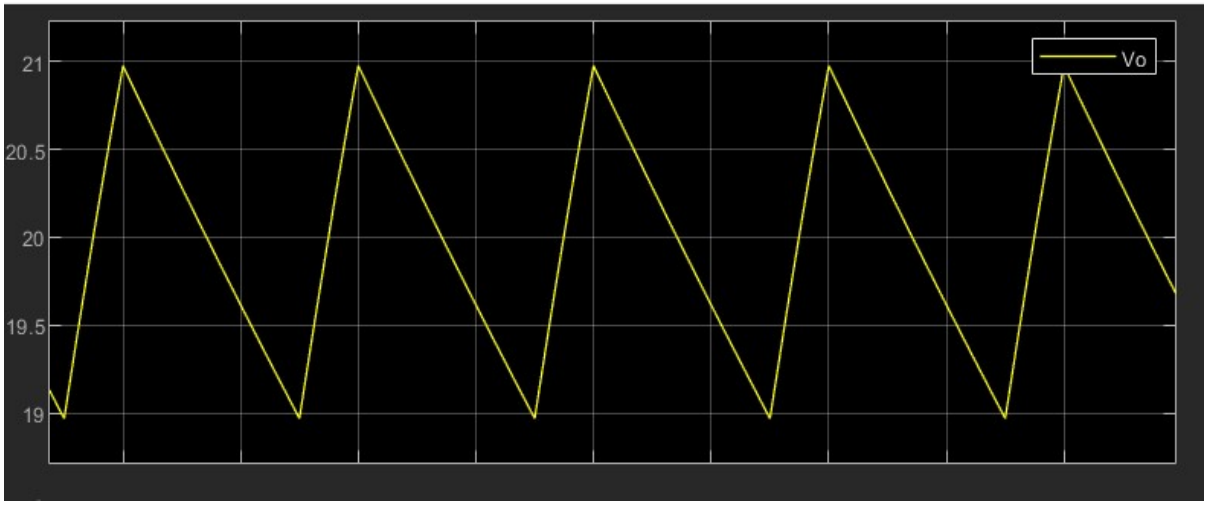

Fig 1: V_o

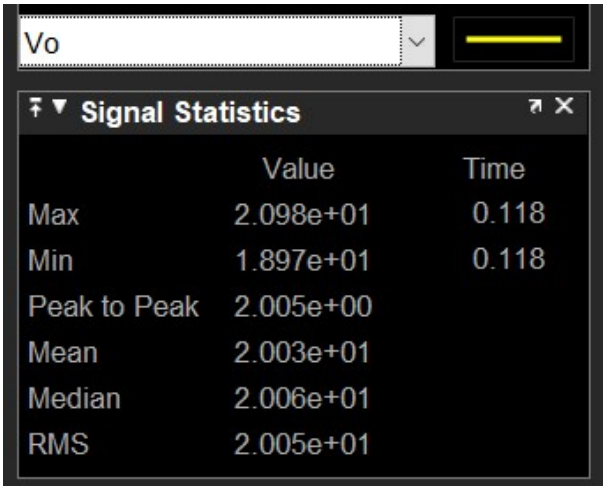

Fig 2: *Signal stats for* V_o

$$Expected\ Ripple = 10\ \%$$

$$Obtained\ Ripple = \frac{2.005}{20.03} \cdot 100\ \% = 10.0099\ \%$$

b) *For* I_L,

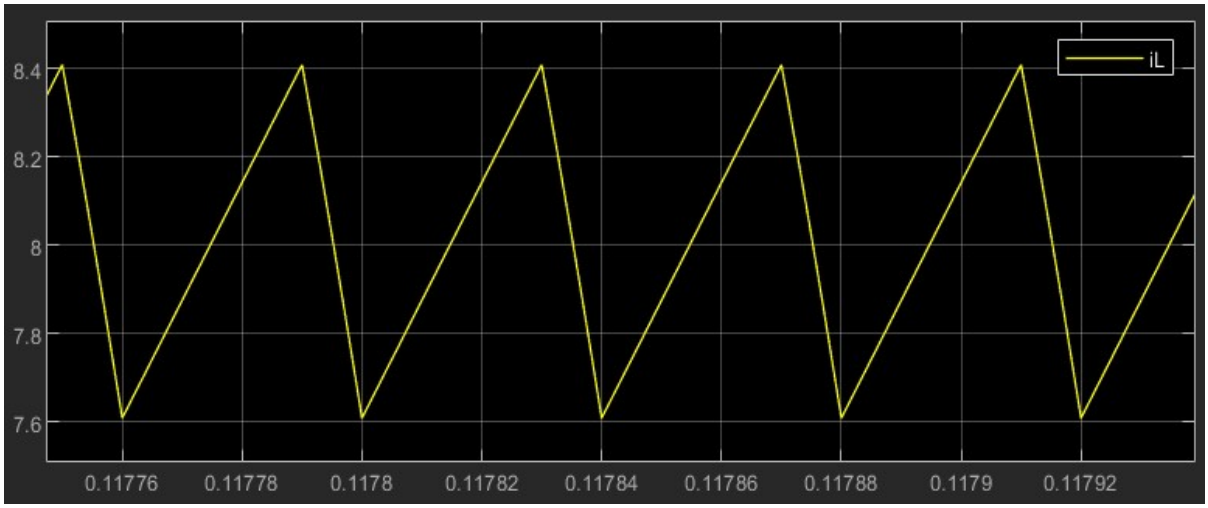

Fig 3: I_L

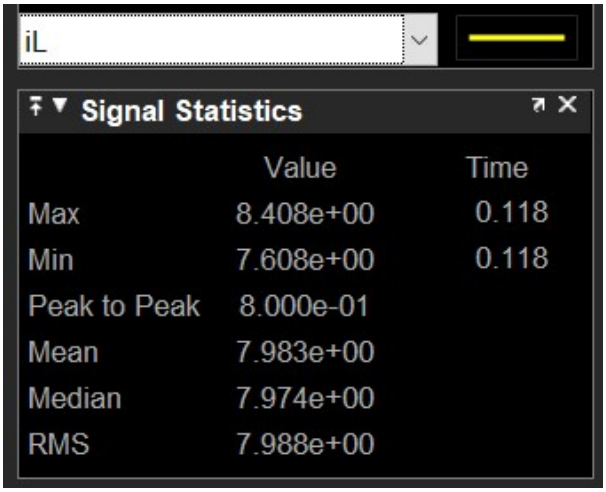

Fig 4: *Signal stats for* I_L

$$Expected\ Ripple = 10\ \%$$

$$Obtained\ Ripple = \frac{0.8}{7.983} \cdot 100\ \% = 10.0213\ \%$$

c) For I_o,

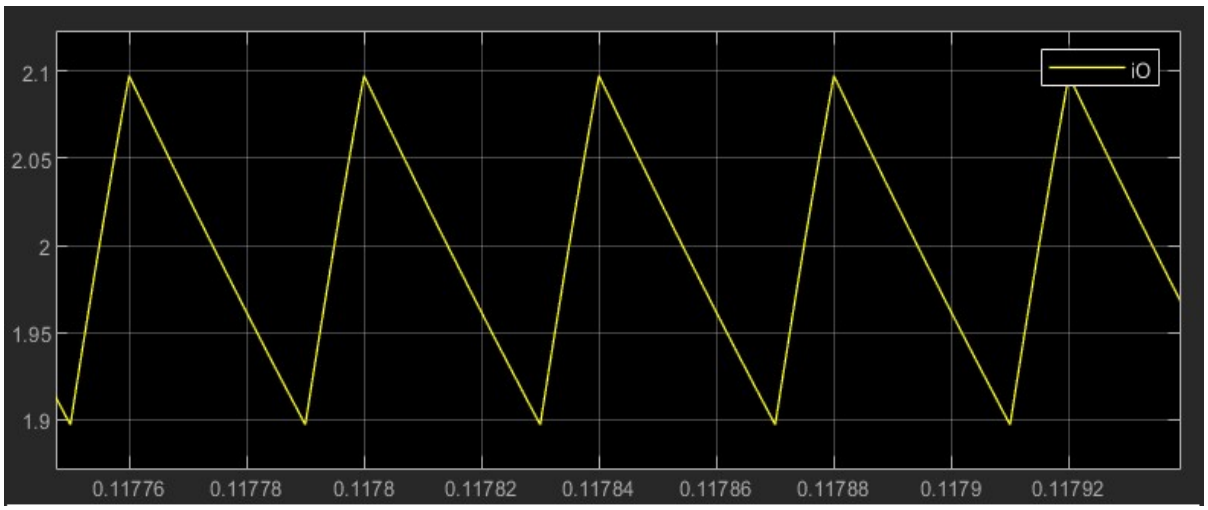

Fig 5: I_o

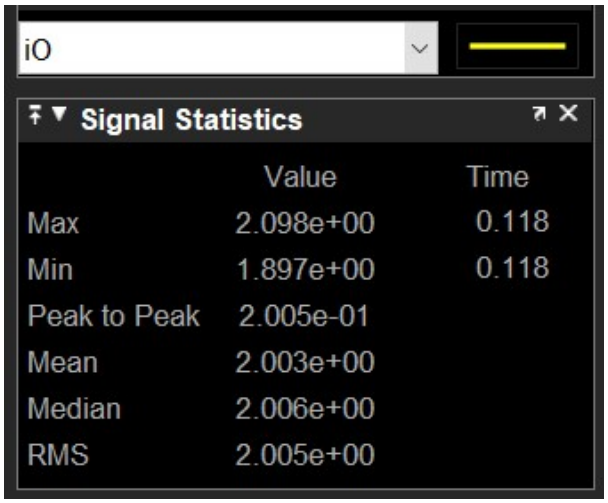

Fig 6: *Signal stats for* I_o

$$Expected\ Ripple = 10\ \%$$

$$Obtained\ Ripple = \frac{0.2005}{2.003} \cdot 100\ \% = 10.0099\ \%$$