d) The output voltage ripple.

The ripple in the output voltage Δv_O can be determined as:

$$\Delta v_O = \frac{V_O D}{f R_L C} = \frac{16 \times 0.4}{5 \times 100 \times 10^3 \times 80 \times 10^{-6}} = 0.16 \;\; V$$

Q3 [5 marks]

A flyback DC converter has a supply voltage of $V_s = 24$, $N_1/N_2 = 3$, a switching frequency $f = 40$ kHz, $L = 500$ μH, and $C = 200$ μF. This converter supplies a load of $R_L = 5\,\Omega$ at an average output voltage of $V_O = 5$ V. For this converter, determine:

a) The duty cycle D.

The duty-cycle can be determined as:

$$\frac{V_O}{V_s} = \frac{D}{1-D}\left(\frac{N_2}{N_1}\right) \Longrightarrow \frac{D}{1-D} = \frac{15}{24} \Longrightarrow D = 0.385$$

b) The inductor average current I_L.

The average inductor current I_L can be determined using I_s as:

$$I_L = \frac{I_s}{D} = \frac{V_O^2/(V_s R_L)}{D} = \frac{5^2/(24 \times 5)}{0.385} = 0.542 \;\; A$$

c) The maximum and minimum values of the inductor current.

The maximum (I_1) and minimum (I_2) inductor currents can be determined using the current ripple in the inductor Δi_L, which is determined as:

$$\Delta i_L = \frac{D V_s}{f L} = \frac{0.385 \times 24}{40 \times 10^3 \times 500 \times 10^{-6}} = 0.46 \;\; A$$

$$I_1 = I_L + \frac{\Delta i_L}{2} = 0.542 + \frac{0.46}{2} = 0.772 \;\; A$$

$$I_2 = I_L - \frac{\Delta i_L}{2} = 0.542 - \frac{0.46}{2} = 0.312 \;\; A$$

d) The output voltage ripple.

The ripple in the output voltage Δv_O can be determined as:

$$\Delta v_O = \frac{V_O D}{f R_L C} = \frac{5 \times 0.385}{5 \times 40 \times 10^3 \times 200 \times 10^{-6}} = 0.048 \;\; V$$