Name: 

1) Given the following converter, assume that at any instant the switch will move between position 1 and 2, with a switching frequency of $f_{sw}$ and a duty cycle of 50%.

![Diagram of the converter](image)

(i) Determine the converter voltage conversion ratio (2 points).

\[ V_L(t) = V_g, \quad i_C = \frac{-V}{R} \approx -\frac{V}{R} \]

\[ V_L(t) = V_g - V, \quad i_C \approx I_L - \frac{V}{R} \]

\[ V_L(t) = V_g \times DT_5, \quad V_L(t) = V_g - V \times DT_5 \]

\[ 0 < t < DT_5, \quad \text{Switch in position 1} \]

\[ DT_5 < t < T_5, \quad \text{Switch in position 2} \]

\[ V_L(t) = V_g \times DT_5 + (1-D) \frac{V}{R} \]

\[ \frac{V}{V_g} = \frac{A}{1-D} = \frac{A}{1-0.5} = 2 \]

(ii) Determine the average value of the inductor current (3 points).

\[ \langle i_C \rangle_{T_S} = 0 \]

\[ \frac{1}{T_S} \left[ DT_5 \left( -\frac{V}{R} \right) + (1-D) \frac{V}{R} \right] = 0 \]

\[ \frac{V}{V_g} = \frac{I_L}{(1-D) R} = \frac{V_g}{(1-D)^2 R} \]

\[ D = 0.5 \Rightarrow I_L = \frac{4V_g}{R} \]
(iii) Draw the inductor current waveform and calculate the inductor current ripple (3 points).

\[ \Delta i_L = \frac{D T_s V_g}{2L} = \frac{0.5 \times T_s V_g}{2L} = \frac{T_s V_g}{4L} \]

(iv) Determine the value of the load resistance at which the converter will operate at boundary of CCM and DCM. Express your answer in terms of circuit parameters (2 points).

At the boundary of CCM and DCM:

\[ I_L = \Delta i_L \]

\[ \frac{V_g}{(1-D)^2 R} = \frac{D T_s V_g}{2L} \]

\[ R = \frac{2L}{(1-D)^2 \times D T_s} = \frac{16L}{T_s} \]

\[ \frac{2L}{R T_s} = \frac{1}{8} \]