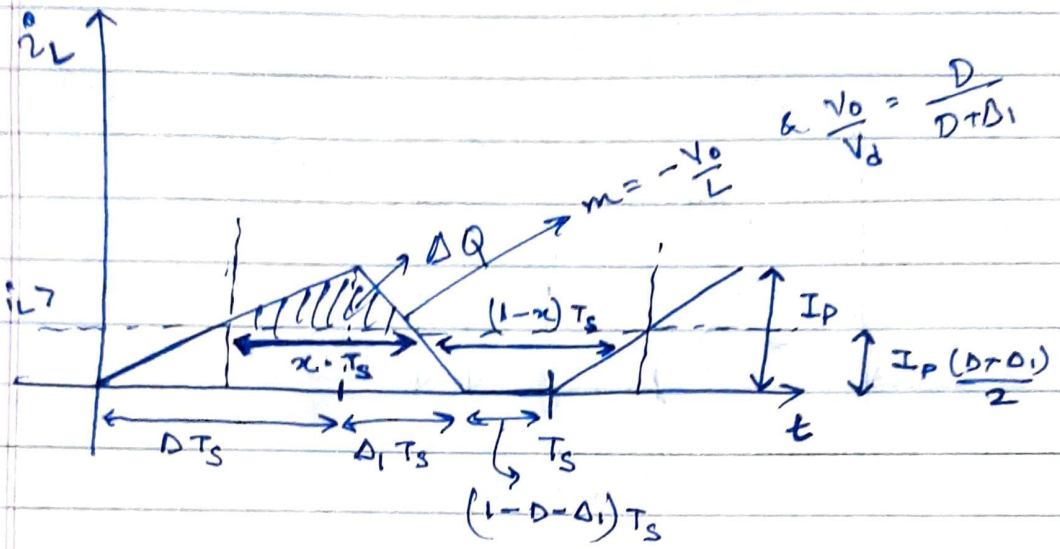
19010042 – CHIRAG GARG

BUCK CONVERTER

For Buck in DCM we have ⟶



$$\Delta Q = \frac{1}{2} x \cdot T_s \cdot I_p \left(\frac{2-(D+\Delta_1)}{2} \right) = \frac{1}{2} \left((1-x)T_s + (1-(D+\Delta_1))T_s \right) I_p \frac{(D+\Delta_1)}{2}$$

$$\Rightarrow \quad x \cdot (2-(D+\Delta_1)) = (D+\Delta_1)(2-(D+\Delta_1)-x)$$

$$\Rightarrow \quad x \left(\frac{2}{D+\Delta_1} - 1 \right) = 2-(D+\Delta_1) - x$$

$$\Rightarrow \quad x \cdot \frac{2}{D+\Delta_1} = 2-(D+\Delta_1) \quad \Rightarrow \quad x = \frac{(2-(D+\Delta_1))(D+\Delta_1)}{2}$$

Also, $I_p = \frac{V_d}{L} \Delta_1 T_s = V_d \cdot \frac{D}{D+\Delta_1} \cdot \frac{\Delta_1 T_s}{L}$

$$\Rightarrow \Delta V_o = \frac{\Delta Q}{C} = \frac{1}{C} \cdot \frac{1}{2} \cdot \frac{(2-(D+\Delta_1))(D+\Delta_1)}{2} T_s \cdot V_d \cdot \frac{D}{D+\Delta_1} \cdot \frac{\Delta_1 T_s}{L} \cdot \frac{[2-(D+\Delta_1)]}{2}$$

$$\Rightarrow \boxed{\Delta V_o = \frac{(2-(D+\Delta_1))^2 T_s^2 \cdot V_d \cdot D \cdot \Delta_1}{8LC}}$$

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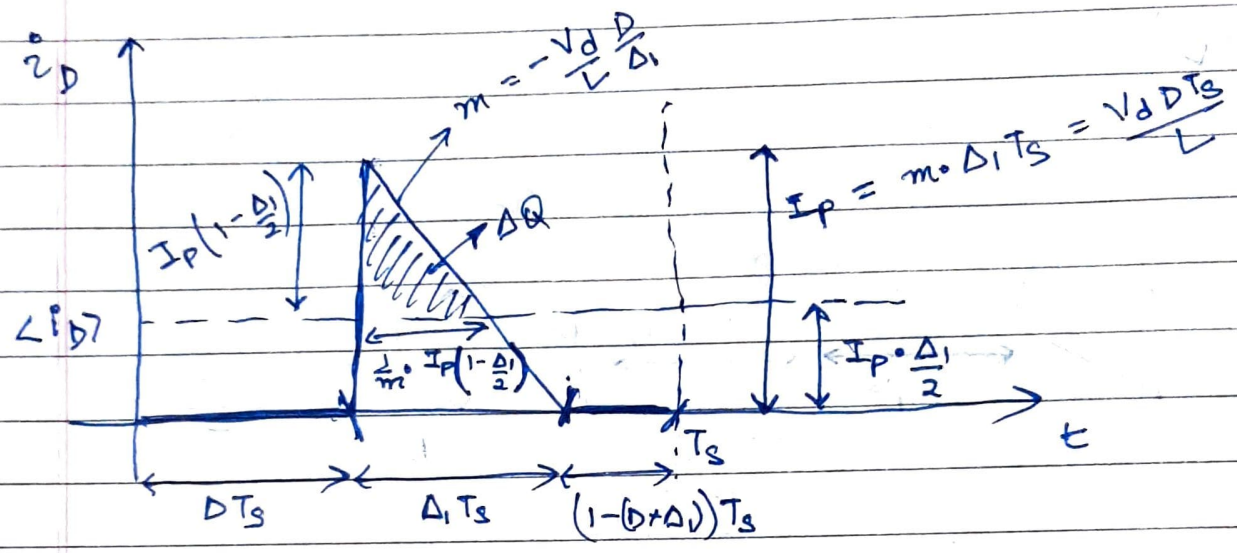
BOOST CONVERTER

For Boost in DCM we have →



$$\Delta Q = \frac{1}{2} \cdot \left[I_p \cdot \left(1-\frac{\Delta_1}{2}\right)\right]^2 \cdot \frac{1}{m} = \frac{I_p^2 \, (2-\Delta_1)^2}{8} \cdot \frac{\Delta_1 L}{V_d D}$$

$$\Rightarrow \Delta Q = \frac{\Delta_1 L}{V_d D} \frac{(2-\Delta_1)^2}{8} \cdot \left(\frac{V_d D}{L}\right)^2 T_S^2 = \frac{V_d D T_S^2}{8L} \Delta_1 \cdot (2-\Delta_1)^2$$

$$\Rightarrow \Delta V_o = \frac{\Delta Q}{C} \cdot$$

$$\Rightarrow \boxed{\Delta V_o = \frac{V_d \cdot D \cdot T_S^2 \cdot \Delta_1 \cdot (2-\Delta_1)^2}{8LC}}$$

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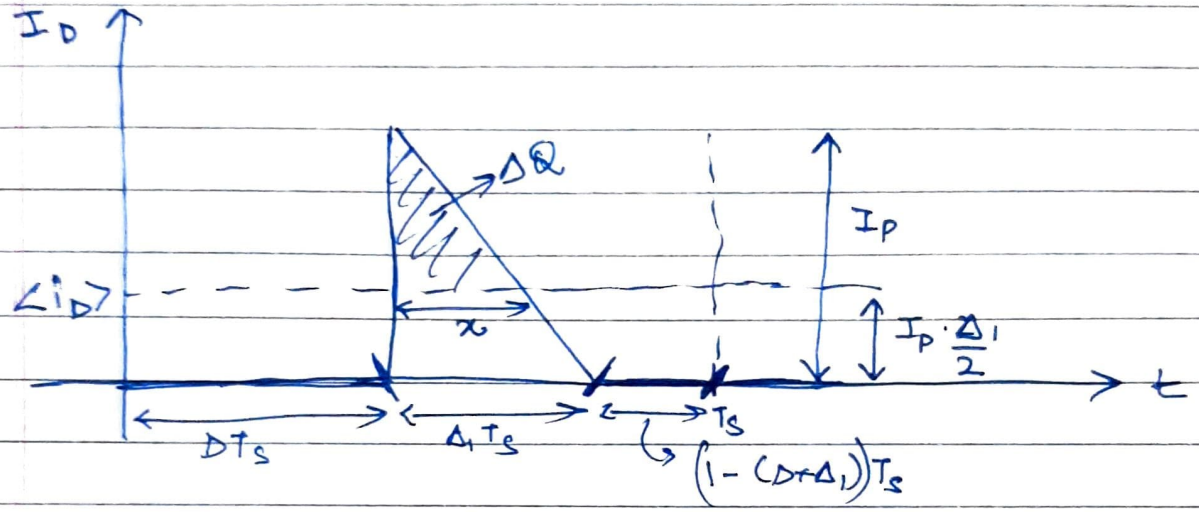
BUCK-BOOST CONVERTER

For Buck-Boost in DCM, we have →



We have, $I_L = I_p \cdot \frac{\Delta_1}{2} = \frac{V_d}{2L} D T_S (D+\Delta_1)$

$$\Rightarrow I_p = \frac{2}{\Delta_1} I_L$$

Also, $\frac{I_p\left(1-\frac{\Delta_1}{2}\right)}{x} = \frac{I_p}{\Delta_1 T_S} \Rightarrow x = \frac{\Delta_1 T_S}{2}(2-\Delta_1)$

$$\Rightarrow \Delta Q = \frac{1}{2} \cdot \frac{\Delta_1 T_S}{2}(2-\Delta_1) \cdot I_p\left(\frac{2-\Delta_1}{2}\right) = I_p \cdot \frac{\Delta_1 T_S}{8}(2-\Delta_1)^2$$

$$\Rightarrow \Delta V_b = \frac{\Delta Q}{C} = \frac{\Delta_1 T_S}{8}(2-\Delta_1)^2 \cdot \frac{V_d}{2L} D \cdot T_S (D+\Delta_1)$$

$$\Rightarrow \boxed{\Delta V_b = \frac{V_d T_S^2}{16L} \cdot D \cdot \Delta_1 \cdot (D+\Delta_1) \cdot (2-\Delta_1)^2}$$