2.1 Derive an expression for the dc voltage transfer function of the lossless buck converter operating in CCM using the diode voltage waveform.

1. The voltage at the input of Lower Pass filter L-C-RL, we can see $V_{AB} = -V_D$

inhence we can know $V_{AB} = V_I$ (when $0 < t \leq DT$)

$V_{AB} = 0$ (when $DT < t \leq T$)

And average will be steady zero

So, the dc voltage will be same to average input of the output filter.

$$V_O = \frac{1}{T}\int_0^T V_{AB}\,dt = \frac{1}{T}\int_0^{DT} V_I\,dt = DV_I$$

$\therefore M_{VDC} = D$

2.2 A buck converter has $V_I = 22$–32 V, $V_O = 14$ V, $I_O = 0.2$–2 A, and $f_s = 40$ kHz. Find the minimum inc L required to maintain the converter operation in the continuous conduction mode.

Maxium load: $R = \frac{V_O}{I_{O\min}} = 14/0.2 = 70\,\Omega$

minum dycle: $D = M_{VDC} = \frac{V_O}{V_{max}} = 14/32 = 0.4375$

then $L_{min} = [70 \times (1 - 0.4375)] / (2 \times 40 \times 10^3)$

$= 492.2\,\mu H$

let $L = 550\,\mu H$

2.3 For the converter given in Problem 2.2, find the voltage and current stresses of the transistor and diode.

From above, we can know Voltage stress:

$V_{S\max} = V_D = V_I = 32V$

current stresses:

$I_{S\max} = I_{D\max} = I_{O\max} = I_{O\max} + \frac{V_O(1 - D_{\min})}{2 f_s L}$

$$= 2 + \frac{14 \times (1 - 0.437)}{2 \times 40 \times 10^3 \times 0.5 \times 10^{-3}} = 2.1794$$