Buck Converter Design – 12 V to 5 V @ 1 A (fs = 50 kHz)

Design Question

Design a continuous-conduction-mode (CCM) buck converter to supply a 1 A load at 5 V from a 12 V input source. The switching frequency is 50 kHz. Allow a 20% peak-to-peak inductor current ripple relative to the 1 A load current (ΔI_L = 0.2 A) and limit the peak-to-peak output voltage ripple to 0.1 V (≈2% of 5 V). Determine the duty cycle, required inductance, minimum output capacitance (ideal, ESR neglected), key currents (peak/valley/RMS), and basic ratings for the switch, diode, and capacitor.

Parameter	Symbol	Value
Input voltage	V_in	12.00 V
Output voltage	V_out	5.00 V
Load current	I_out	1.00 A
Switching frequency	f_s	50 kHz
Inductor ripple (pp)	ΔI_L	0.200 A (20% of I_out)
Output ripple (pp)	ΔV_out	0.100 V (~2% of V_out)